TRAC Innovative Visualization Techniques

TRADOC Analysis Center
700 Dyer Road
Monterey, California 93943-0692

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Cardy Moten III
Heather Newton
Leroy Jackson

TRADOC Analysis Center
700 Dyer Road
Monterey, California 93943-0692

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14. ABSTRACT

The purpose of this report is to discuss a method to design visualizations. A mission essential task of the TRADOC Analysis Center (TRAC) is to conduct studies that inform key decisions my by Training and Doctrine Command (TRADOC), Army, and Joint leaders. Because of the complexity of these decisions, TRAC analysts have a constant challenge to present complex analysis results in a simple and sophisticated way. Therefore, TRAC analysts need a way to analyze the effectiveness of their visualization design choices. Currently, TRAC does not have a methodology to analyze visualizations used to support an analysis story.

Our research team developed a visualization design methodology to create effective visualizations that support an analysis story. First, we based our methodology on the latest research on design thinking, cognitive learning, and visualization principles. Second, our methodology provides a solid foundation to develop, analyze, and present visualizations. We accomplish this by utilizing a story planning outline and presentation format that is audience focused and presents the most critical information necessary for decision knowledge. Finally, our methodology extends the goodness of the current TRAC documentation standard by fostering communication focused on the decision maker; rapidly prototyping visualizations that foster innovation and creativity; and utilizing a repeatable methodology that provides credibility to the visualization choices used in a presentation to a decision maker.

15. SUBJECT TERMS

Data visualization, design thinking, cognitive theory of multimedia learning (CTML), assertion-evidence

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Table of Contents

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List of Figures

List of Figures

Executive Summary

The purpose of this report is to discuss a method to design visualizations. A mission essential task of the TRADOC Analysis Center (TRAC) is to conduct studies that inform key decisions my by Training and Doctrine Command (TRADOC), Army, and Joint leaders. Because of the complexity of these decisions, TRAC analysts have a constant challenge to present complex analysis results in a simple and sophisticated way. Therefore, TRAC analysts need a way to analyze the effectiveness of their visualization design choices. Currently, TRAC does not have a methodology to analyze visualizations used to support an analysis story.

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TRAC Innovative Visualization Techniques
Chapter 1
Introduction

Background

The Training and Doctrine Command Analysis Center (TRAC) has a mission to "Provide relevant and credible operations analysis to inform decisions.[1]" A mission essential task to accomplish this goal is to "Conduct the studies that inform critical decisions made by TRADOC, Army, and Joint leaders.[2]"The analysis executed in these studies is complex and describing it can be difficult. In addition to this complexity, an operations research analyst could have limited experience with choosing an appropriate visualization technique to aid in presenting and understanding analysis results. Moreover, the vast amount of visualization techniques and technologies increase the difficulty of the analyst's final choice.

As part of its professional development for junior analysts, the TRAC Analyst Development Program (TADP) teaches various aspects of the TRAC mission, organization, and analysis process to improve the capabilities of junior analysts. The TADP consists of eight courses:

- TRAC Organization and Mission.
- How Analysis Supports Army Force Management.
- Overview of Army and DoD Organizations.
- Army Analytical Organizations Outside of TRAC.
- Study Project Life Cycle.
- Types of Projects.
- Methods, Models, and Tools.
- Art of Analysis.

Of the eight courses in the TADP, the Study Project Life Cycle course details the steps that are necessary to plan, prepare and conduct a study as shown in Figure 1. A review of the figure shows that the TRAC study process consists of three main phases: Planning, Preparation, and Execution. The Execution phases consists of the two subtasks of Analysis and Reporting/Documentation. The TRAC Study Director's Guide details all of these phases and sub-tasks in detail.[3] Although it is beyond the scope of this report to discuss the pertinent details of each phases we will note that of all the phases in the study process, the planning

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[1]TRADOC Analysis Center. *About TRAC*. URL: http://www.trac.army.mil/about.html.

[2]Ibid.

[3]Lynn Leath. *Study Director's Guide: A Practical Handbook for Planning, Preparing, and Executing a Study*. Tech. rep. TRAC-F-TM-09-023. 255 Sedgwick Avenue, Fort Leavenworth, KS 66027-2345: TRADOC Analysis Center, 2010.

phase receives the most attention. The TRAC Study Director's Guide details the following items as part of the planning phase:

- Analyze the directive;
- Conduct background research;
- Identify specific, implied, and essential tasks;
- Review analysis assets;
- Identify constraints, limitations, and assumptions;
- Write restated mission;
- Develop study concept;
- Develop methodology;
- Assign responsibilities;
- Write/assign study plan.[4]
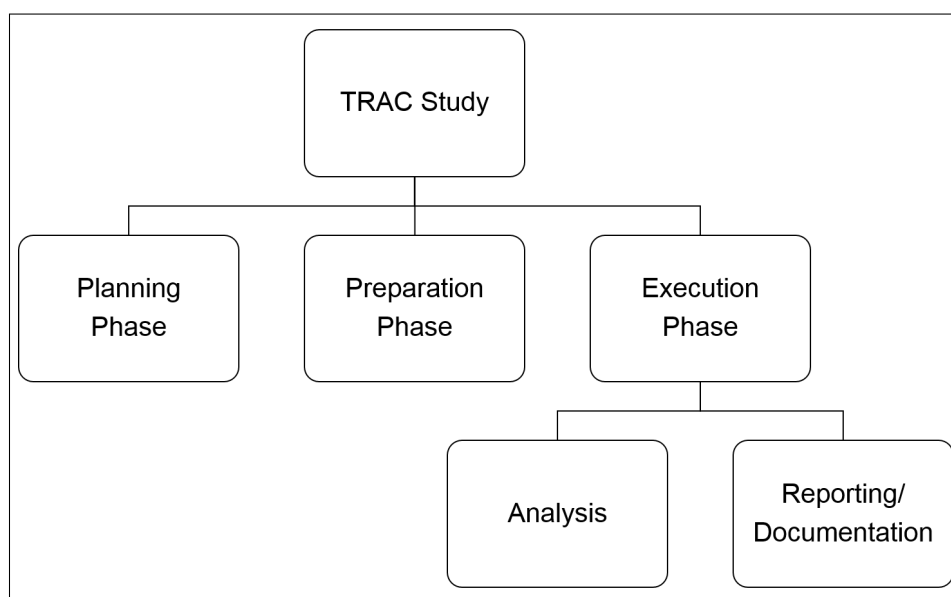
Figure 1. Overview of the TRAC Study Process.

While it is important to have a deliberate planning process for a study, a review of the TRAC study guide shows that the level of detail for the execution phases, specifically the Reporting and Documentation phase is missing from this critical document. This report fills this gap by providing a planning methodology to use when reporting the analysis findings, specifically if analysts use a graphic or visualization to augment the study results.

Problem Statement

In this study, we will explore and organize methods that assist analysts in deciding on a data visualization technique to implement in a technical document, report, demonstration, or

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[4]Ibid.

presentation that provides a decision maker or stakeholder the necessary context to support their decision.

Visualization Definition

Prior to deciding on which visualization to use in a study or presentation, we should first define the term visualization. Visualization is the process of illustrating data in a meaningful way. Visualization in the literature mostly applies to non-abstract environmental data such as satellite imagery.[5] However, most of the data TRAC analysts study is abstract data—data that is numerical or symbolic in nature. According to Fry, information visualization is "the use of computer-supported, interactive, visual representations of abstract data to amplify cognition."[6] Therefore, we will use the term information visualization throughout this report because of its connection to abstract data. Furthermore, Munzer emphasizes that the function of an information visualization is to support the understanding of a problem, and the visualization requires validation.[7] In other words, does the visualization show the right information to support the presentation of the analysis findings?

This definition is important because since an information visualization has a particular function, this implies that the information visualization is the product of a design process. In essence, utilizing design principles—in particular, design thinking is critical to ensure efficient communication of the analysis results.[8] Brown states that design thinking is "a methodology that imbues the full spectrum of innovation activities with a human-centered design ethos."[9] To put it another way, design thinking is an iterative process that combines divergent and convergent ideas into a product that will meet the customer's needs; which in the case of this report, the customer is the decision maker and the product is an information visualization. If that is the case, then the analyst must have a plan on what information visualization to use in the final presentation of their study results which is the focus of the remainder of this document.

Issues for Analysis

1. What is the current collection of methods TRAC analysts use for visualizing findings to senior leaders in high-profile technical documents, reports, demonstrations, or presentations?
2. What are the issues TRAC analysts encounter with visualizing and presenting findings to decision makers?
3. What are the current workarounds TRAC analysts use to address these issues?

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[5]Benjamin Jotham Fry. "Computational information design". PhD thesis. Massachusetts Institute of Technology, 2004, p. 39.

[6]Ibid., p. 39.

[7]Tamara Munzner. *Visualization Analysis and Design*. CRC Press, 2014.

[8]Fry, "Computational information design", op. cit.

[9]Tim Brown. "Design thinking". In: *Harvard business review* 86.6 (2008), p. 84.

4. What other visualization techniques can assist TRAC analysts with addressing these issues?
5. What are the best situations to apply these visualization techniques

Constraints, Limitations, and Assumptions

- Constraints
  - The project completion data is no later than 30 September 2016.
  - Project costs are limited to travel supported by TRAC-Monterey.
- Limitations
  - The focus on the project will be on the visualization of information in high-profile technical documents, reports, demonstrations, and presentations normally presented to a senior leader.
- Assumptions
  - The study team can get a consensus of the types of high-profile technical documents, reports, demonstrations, and presentations TRAC uses to support senior leader decisions.

Methodology

The execution of this project will follow the technical approach outlined in this section. Figure 2 displays the study plan methodology. Specifically, each block in the figure lists the task title, sub-tasks, the study issues analyzed in the task, and finally the output of the task which is below the blue line. First, the study team will conduct a survey of the current products TRAC develops to present findings and results to senior leaders. The goal of this survey is to find out specifically the key TRAC studies that exemplifies TRAC's mission and use these studies to form the basis for the review of current visualization literature. This section of the methodology will address study issues 1-3, and the output of this section of the study will include TRAC products to use as case studies for visualization refashioning. Next, the study team will survey the literature on the current methods used for visualization. It is important to note here that data for this study is considered any quantitative or qualitative information that is a critical component to convey the necessary context that supports the decision maker's objectives. This section of the study will address study issues 4-5, and the output will be a list of current visualization methods and tools. Finally, the study team will develop a visualization methodology and test this methodology by refashioning current TRAC products and comparing the results. This section of the study also addresses study issues 4 and 5, and the outputs will include example presentation products and this technical report.

Survey current TRAC study products and analysis tools.
Interview center directors. Interview study leads. Identify types of high-profile technical documents, reports, demonstrations, and presentations. 1. What is the current collection of methods TRAC analysts use for visualizing findings to senior leaders in high-profile technical documents, reports, demonstrations, and presentations? 2. What are the issues TRAC analysts encounter with visualizing and presenting findings to decision makers? 3. What are the current workarounds TRAC analysts use to address these issues?
TRAC products to use as case studies for visualization refashioning.

Survey current data visualization literature
Review data visulization technique literature. Review visualization design literature. Review visualization tools literature. 4. What other visualization techniques can assist TRAC analysts with addressing these issues? 5. What are the best situations to apply these visualization techniques?
List of current visualization methods and tools.

Develop visualization design methodology.
Create visual design process. Test visual design process. 4. What other visualization techniques can assist TRAC analysts with addressing these issues? 5. What are the best situations to apply these visualization techniques?
Example presentation products. Technical Report.

Figure 2. Study plan methodology.

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Chapter 2
Methodology

Fry describes the process of moving from raw data to an understanding of the data in seven steps:[10]

1. Acquire the data from the relevant source.
2. Parse the data into a tidy structure.
3. Filter the data for items of interest.
4. Mine the data for meaningful patterns.
5. Represent the data visually as simple as possible while maintaining the proper context.
6. Refine the data representation to make it more engaging.
7. Interact with the data to gain additional insights.

While all these steps are necessary, the focus of this chapter will be on the representation of the data as an information visualization and the follow-on refinement and interaction (steps 5-7). Before we explore how to design the information visualization, it is important we first understand the perspective of the people that will ultimately view the information and ways they will process what they are seeing.

Army Design Methodology

A couple of fundamental principles of presenting information is to know your audience and understand the context of the problem you are assisting in solving. These principles are especially important when the primary audience is senior military leaders because of their unique experience in dealing with operational military problems. In this section, we will briefly describe the Army design methodology to provide the reader a reference point in understanding a planning technique taught to senior military leaders that can guide their thought process in understanding the context of the decision problem.

According to Army doctrine, the Army design methodology is a technique "for applying critical and creative thinking to understand, visualize, and describe unfamiliar challenges and approaches to solving them."[11] In other words, this method gives a commander a way to establish the links that connect the problem and the solution. Commanders establish this link through an iterative and collaborative process with their staff, subordinates, and other

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[10]Fry, "Computational information design", op. cit., p. 13.

[11]U.S. Department of the Army. *ATP 5-0.1 Army Design Methodology*. Washington D.C.: Government Printing Office, 2015.

partners by gaining insights in each participant's shared understanding of the problem.[12] As a result of this process, the commander has the capability to visualize the operational approach to solving the operational problem and the ability to "provide a clear commander's intent and concept of operations."[13]

Army Design Methodology History

The Army design methodology is a planning process that is an application of design thinking and systems thinking. Tim Brown, CEO of IDEO, describes design thinking as "a human-centered, creative, iterative, and practical approach to finding the best ideas and ultimate solutions."[14] According to doctrine, systems thinking "focuses on promoting our understanding of events, looking for patterns of behavior, and seeking underlying systemic interrelationships that are responsible for patterns of behavior."[15] This method developed from the Israel Defense Force method of Systemic Operational Design (SOD).[16] The use of this methodology for the Army started in 2005 as an academic exercise to develop a way for commanders to think about complex operating environments like Iraq. In particular, the senior military leaders at the time wanted to gain insight into the relationship between what they viewed as two contradictory concepts: the progression of the war towards an insurgency and civil war and "the reality that somehow 'culture' was a critical component of what was happening."[17] Later that year, the Army implemented SOD in the Unified Quest 2005 exercise. Consequently, the use of SOD provided two key insights on the appropriate use of design. First, design aids the commander in understanding and where to modify strategic guidance. Second, design helps the commander to frame the problem and provide an operational solution to the problem.[18]

Tim Brown and David Kelley developed the current Design thinking methodology to solve ill-structured problems.[19] Their methodology is a customer oriented approach that applies a five-step process of empathize, define, ideate, prototype, and test. As shown in Figure 3 these steps help the designer to not only focus on the problem from the customer's perspective but to also collaborate with other team members and the client throughout the process when solving the problem. Furthermore, the design thinking process encourages the designer to take on a "beginner's mindset" to allow for a compilation of ideas and reduce

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[12]U.S. Department of the Army. *ADRP 3-0 Operations*. Washington D.C.: Government Printing Office, 2016.

[13]Ibid.

[14]Brown, "Design thinking", op. cit.

[15]Joint Warfighting Cener. "Design in Military Operations–A Primer for Joint Warfighters". In: *JWFC Doctrine Pamphlet* 10 (2010).

[16]School of Advanced Military Studies. *Art of Design, Student Text, Version 2.0*. U.S. Army Command and General Staff School. Fort Levanworth, KS, 2010. URL: `http://usacac.army.mil/cac2/CGSC/events/sams/ArtofDesign_v2.pdf`.

[17]Ibid.

[18]Ibid.

[19]Linda Tischler. *Ideo's David Kelley on "Design Thinking"*. 2009. URL: `http://www.fastcodesign.com/1139331/ideos-david-kelley-design-thinking`; Tim Brown. *Change by design*. Collins Business., 2009.

the influence of their biases.[20] The link between the Army design methodology and design thinking is that the commander is the customer and the staff and subordinates serve as the design team. Similar to design thinking, the Army design methodology emphasizes that the commander forms a planning team that seeks a solution to the operational problem through open dialogue and collaboration. Additionally, the commander should find personnel that have the best knowledge of the problem regardless of rank.[21] This understanding of design thinking is important because the final result of this process will be a precise knowledge of the operational problem with a proposed solution that will drive further planning through the Military Decision Making Process (MDMP).
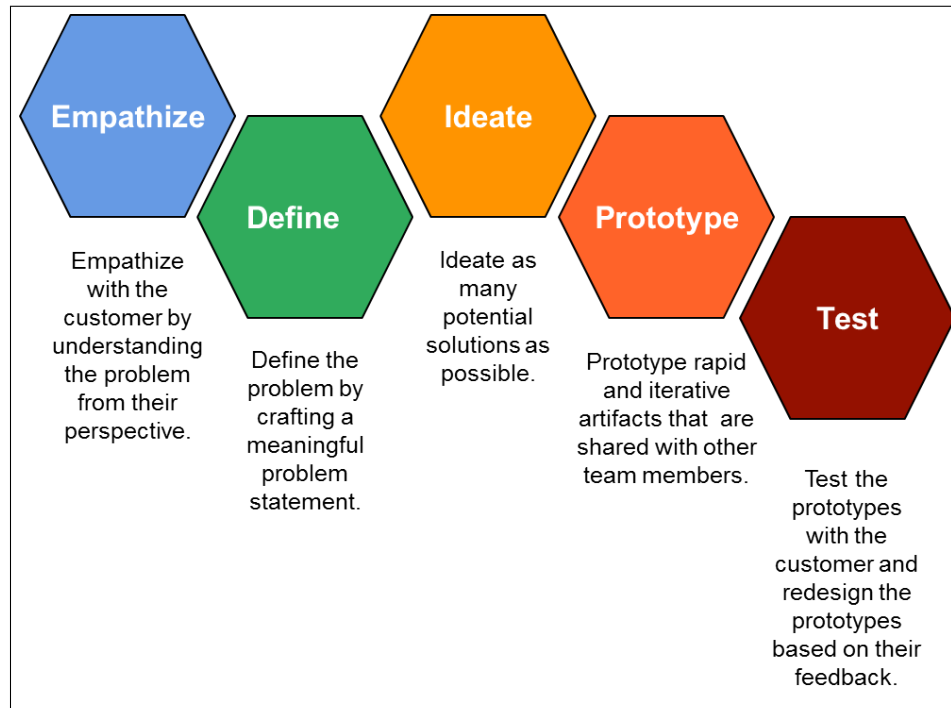
Figure 3. Design Thinking Process adapted from Plattner (2010).

Army Design Methodology Application

When applying the principles of design and system thinking to operational planning, it is important to understand that this thought process is strategic in nature. Brown, for example, supports this when he compares the tasks of improving an already developed idea vice creating an idea that better meets the needs of the customer.[22] In essence, the former task is tactical because it limits amount of value created for the customer while the latter task creates new value for the customer. Hence, the Army design methodology achieves this same strategic effect by creating new value in the form of shared understanding of the

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[20]Hasso Plattner. "Bootcamp bootleg". In: *Design School Stanford, Palo Alto* (2010). URL: http://dschool.stanford.edu/wp-content/uploads/2013/10/METHODCARDS-v3-slim.pdf, p. 6.

[21]U.S. Department of the Army, *ATP 5-0.1 Army Design Methodology*, op. cit.

[22]Brown, "Design thinking", op. cit.

operational environment for the commander and staff during their subsequent planning and execution of the mission.

Figure 4 illustrates how a military commander applies the Army design methodology to an operational problem. First, an environmental frame is developed that visualizes the current state of the operational environment and the desired future end state the commander desires. Next, is the framing of the operational problem—the operational problem is the specific hurdles that require a solution to move the current state to the desired future state. The proposed solution for this methodology is the operational approach represented by the large arrows. Figures 5 and 6 show a specific application of how to apply this method to the current operational problem and the desired end state. What is important to note when examining these figures is the use of two important design elements: the sketch and the narrative. The sketch is important because it is a primary design tool to help the project team to scope the problem and use visualization to aid in communication.[23] Furthermore, the accompanying narrative provides the necessary detail to understand the relationships and tensions amongst the various actors in the operational problem.[24]

The key takeaway is that the Army design methodology has been a part of the joint professional military education of military officers since 2005, and it is reasonable to expect that most senior leaders will have a familiar basis with this concept.[25] Thus, if the analyst frames the results of analysis in a similar manner, the decision maker potentially could make the appropriate mental connections they need to solve the technical problem. Fortunately, TRAC has a similar method for framing problems. Thus, the analysts have a strong basis for developing the process of how their solution fits in the context of the decision makers problem.

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[23] Monica E Cardella, Cynthia J Atman, and Robin S Adams. "Mapping between design activities and external representations for engineering student designers". In: *Design Studies* 27.1 (2006), pp. 5–24.

[24] Joint Warfighting Cener, "Design in Military Operations–A Primer for Joint Warfighters", op. cit.

[25] School of Advanced Military Studies, *Art of Design, Student Text, Version 2.0*, op. cit.

Figure 4. Overview of the Army Design Methodology adapted from ATP 5-0.1 (2015).

Current state of Newland

General E President

Anti U.S. solidarity

Legitimacy

Direction

Power

Drug cartels

Sanctuary

Newland Defense Forces

Capabilities

Country X

Country Y

Wealth

Coercion

Control

Obedience

Border clashes

Society

Safety

Refugees

Country Z

Narrative: The Newland defense force controls the population and provides General E power. The President provides direction to the Newland defense force to control the society. The people comply with the direction provided by the President and the Newland defense forces. Those who do not comply are oppressed. In exchange for sanctuary, the drug cartels provide funding to the regime. They harass and terrorize the section of the society that opposes the regime. Countries X and Y provide material capabilities to the Newland defense force and international legitimacy to the regime. In turn, the regime maintains an anti-U.S. policy stance. Over the last six months, over 100,000 persons fled Newland to Country Z. Country Z provides Newland refugees humanitarian assistance and protection. Several border clashes have erupted between Newland defense forces and Country Z in the last three weeks. The antidemocratic dictatorship of Newland oppresses its people, encourages instability in the region, and supports criminal and terrorist activities is unacceptable to U.S. interests.

Figure 5. Example of current problem state adapted from ATP 5-0.1 (2015).

The country of Newland is a friendly democracy that no longer oppresses its people, threatens its neighbors, or provides sanctuary for criminal and terrorist organizations. The society has replaced the Newland defense force as the source of power for the democratic government. The Newland defense force is replaced with an army and navy that serves the society and protects the country from external aggression. Local and national police forces serve the population by providing law and order for society. World democracies support the new government by providing legitimacy and capabilities to the government of Newland and the society. In turn, the new government of Newland supports the rule of law among nations and human rights.
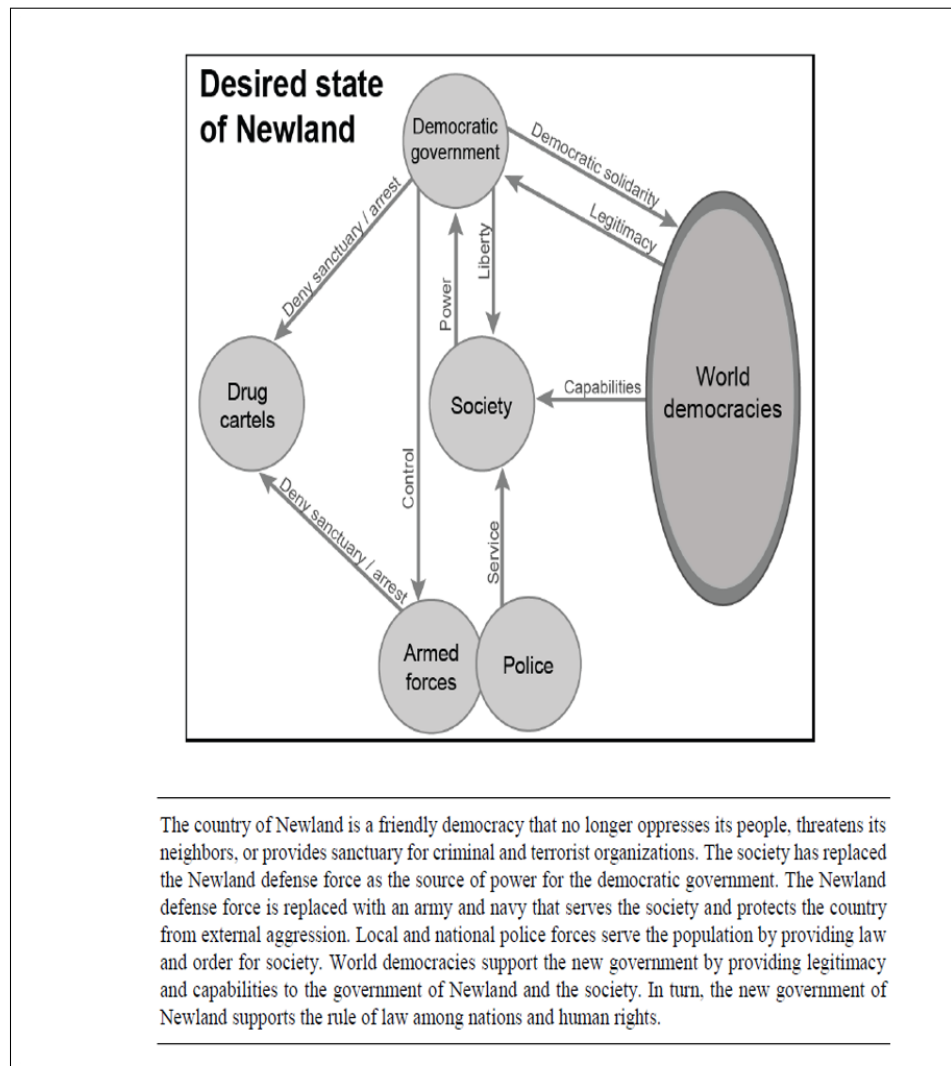
Figure 6. Example of problem end state adapted from ATP 5-0.1 (2015).

General Visualization Principles

In the process of executing the analysis, the analyst, of course, will develop insights from the data into answering their research questions. We use the term exploratory analysis to describe this process. It is important, however, that the analyst keeps in the forefront of their mind of how they will present these insights to the decision maker. We use the term explanatory analysis to describe this process. This section will discuss the process the analyst can use in deciding on which visualization to select in either process, but more so in the explanatory analysis phase. We will begin with a discussion of the Cognitive Theory of Multimedia Learning (CTML) and its connection to the human visual system. In particular, we will discuss how people cognitively process visual and audio information. Next, we will discuss cognitive load, pre-attentive processing, and the Gestalt principles—pattern finding principles that help humans in the processing of visual information. Afterward, we will discuss the use of color in the selection of visualizations. Finally, we will end this section with a discussion of a methodology to analyze selected visualizations.

Human Visual System

Visualization and Cognition

Before creating the visualization, the analyst should first consider how humans interact cognitively with a visualization. In essence, the human visual system is multi-sensory and involves utilizing cognitive resource within sensory memory, short-term memory, and long-term memory.[26]

Cognitive Theory of Multimedia Learning

Mayer developed the CTML as a method to explain the process of how a person interacts with images, written text, and narration.[27] We show an overview of the CTML in Figure 7, and describes its three basic assumptions below:

- Duel channel assumption — humans separate visual and auditory information into two separate channels;

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[26]Richard E. Mayer. *Multimedia Learning*. Second. New York, NY: Cambridge University Press, 2009; Ye Wang et al. "Visuo-auditory interactions in the primary visual cortex of the behaving monkey: Electrophysiological evidence". In: *BMC Neuroscience* 9.79 (2008). DOI: 10.1186/1471-2202-9-79. URL: http://bmcneurosci.biomedcentral.com/articles/10.1186/1471-2202-9-79; Micah M Murray et al. "The multisensory function of the human primary visual cortex". In: *Neuropsychologia* 83 (2016), pp. 161–169; Richard E Mayer and Roxana Moreno. "Nine ways to reduce cognitive load in multimedia learning". In: *Educational psychologist* 38.1 (2003), pp. 43–52; Asif A Ghazanfar and Charles E Schroeder. "Is neocortex essentially multisensory?" In: *Trends in cognitive sciences* 10.6 (2006), pp. 278–285; Robert A. Bartsch and Kristi M. Cobern. "Effectiveness of PowerPoint presentations in lectures." In: *Computing Reviews* 45.2 (2004), pp. 125–126; Michael Alley. *The craft of scientific presentations*. Springer, 1996.

[27]Mayer, *Multimedia Learning*, op. cit.

- Limited capacity assumption — humans have a limited capacity to process information in any one channel;
- Active processing assumption — humans actively learn by developing an appropriate verbal and pictorial model of the information they receive, and integrate that model with prior knowledge in their long term memory.[28]

Along with the three assumptions, the CTML models five essential processes used by the receiver of the information:

- Processing words in the form of narration or text;
- Processing presented pictures;
- Selecting essential words from the narration or text;
- Selecting essential images from the presented pictures;
- Integrating words, images, and prior knowledge into a useful conceptual model.[29]

Reviewing the model in Figure 7, we focus the reader's attention to how the CTML assumptions and processes work together. Starting on the far left of the figure, the receiver of the multimedia presentation, hereafter noted as the learner, receives information from a multimedia presentation in the form of words and pictures. The learner then processes the words and pictures with their eyes and ears channels within their sensory memory for a brief moment. Next, the learner further manipulates the information in their working memory. The figure shows that the working memory first processes the raw materials—the selected words and images the learner received in their sensory memory, into a sound image for words and a visual image for pictures. For instance, when you read the word basketball in this sentence, you more than likely form a mental picture of an orange ball with black ribs surrounding its surface. At the same time, you might also mentally hear the sound a basketball makes as it strikes a hard surface like a basketball court. The learner then develops knowledge within their working memory by organizing the newly formed sound and visual images into a verbal or pictorial model. Furthermore, the learner also integrates any prior knowledge from their long-term memory—the learner's knowledge storehouse with the newly formed mental models in the working memory to create an increased understanding of the new information.[30]

Figure 8 – Figure 10 demonstrate the information path of pictorial, narrated, and spoken information respectively. Of note, the learner develops either a sound or image mental model; they could also convert one model into another form within their working memory, especially when dealing with printed text.[31] Currently, most presentations in TRAC have a combination of graphics, images, and text accompanied by a narration of the presenter. Therefore, the analyst should give consideration to the visualizations they develop and the cognitive load of the consumer of the visualizations used in their presentations.

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[28]Ibid.
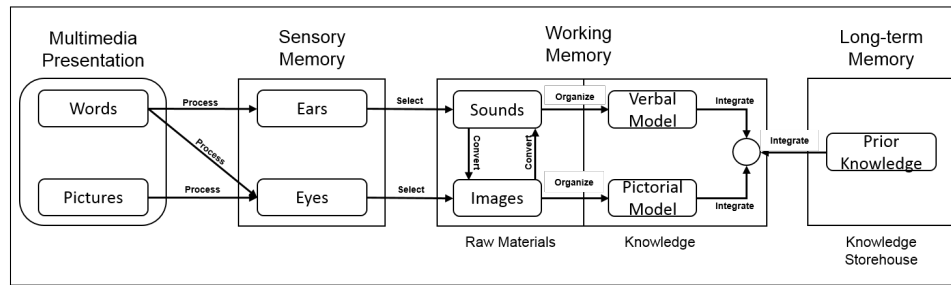
[29]Ibid.

[30]Ibid.

[31]Ibid.

Figure 7. Overview of the Cognitive Theory of Multimedia Learning Model adapted from Mayer (2009).
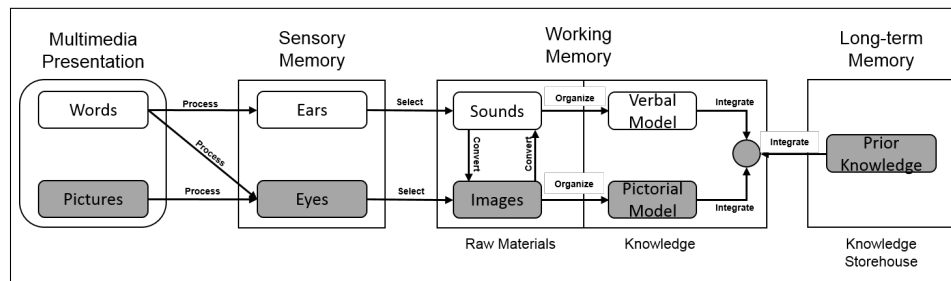

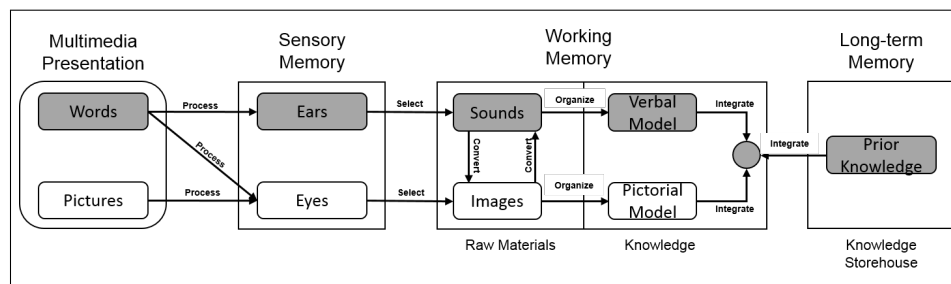**Figure 8.** CTML path of pictorial material adapted from Mayer (2009).

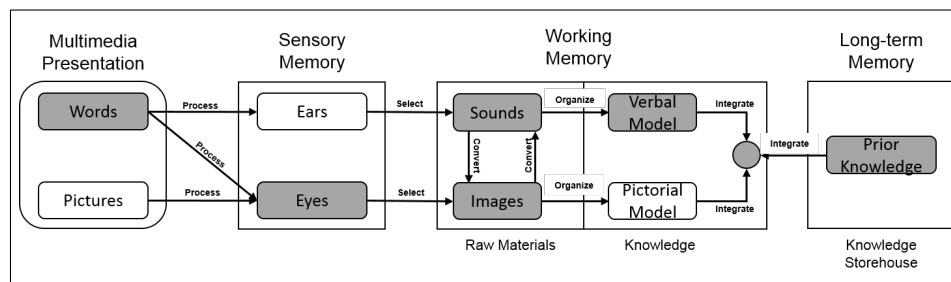**Figure 9.** CTML path of narrated words adapted from Mayer (2009).

Figure 10. CTML path of printed text adapted from Mayer (2009).

Cognitive Load

The working memory of humans is responsible for encoding, storing, retrieving, and forgetting information. The working memory processes various types of information through

16

subsystems for "auditory and visual information, body movements and verbal outputs."[32] Although the working memory is capable of processing multiple forms of information, it does have capacity limitations. Notably, Mayer discusses this process in detail which we used his work to develop a conceptual model of how much capacity a person has in their working memory, especially for visual and auditory information, shown in Figure 11.[33] An examination of this model indicates that the total cognitive processing capacity for the multimedia material of a person consists of the cognitive resources for essential cognitive processing, incidental cognitive processing, and representation processing. We discussed basic cognitive processing in the section on the CTML. Incidental cognitive processing occurs when additional information is present in the multimedia presentation, but it does not add to the learning of the material.[34] For instance, adding background music or images to a chart that are interesting, but not necessary for the learning of the material. Representative cognitive processing happens when you must retain information from a previous slide to understand information in a subsequent slide.[35]

In essence, during a presentation, the members of the audience must utilize their available visual and auditory cognitive resources to process all the information on the slide presented to them. In particular, most of these slides consist of long sentences of bulleted text lists, or a combination of images, graphs, charts, and bulleted lists of text. Hence, the current format of presentation slides tends to increase the cognitive load of the receiver of the information. As a result, the audience must split their attention to discern critical information and do not retain a majority of the information they received within minutes of the conclusion of the presentation.[36]

Figure 12 shows a simple example of this phenomenon. Examining this figure shows that audience members have to process multiple pieces of information simultaneously when viewing this slide. For instance, the audience members must simultaneously process the text and graphic information on the slide. Additionally, the speaker would discuss some additional information about their insights in the study further splitting the attention of the audience. The result is that most of the information on this slide will most likely exit the working memory of the audience with little to no long-term retention of the information which is counter productive to the purpose of the presentation which is to provide meaningful information to the project sponsors.

Bearing in mind, this conceptual model and the combination of visual and auditory information presented in briefings, a natural question that would arise is how much auditory and visual information can the working memory process simultaneously? The research suggests that the working memory can process approximately four chunks of visual and auditory information simultaneously. A review of Figure 12 demonstrates that the example slide contains

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[32]Colin Ware. *Information visualization: perception for design.* Elsevier, 2013.

[33]Mayer and Moreno, "Nine ways to reduce cognitive load in multimedia learning", op. cit.

[34]Ibid.

[35]Ibid.

[36]Idem, "Nine ways to reduce cognitive load in multimedia learning", op. cit.; John Medina. *Brain Rules: 12 Principles for Surviving and Thriving at Work, Home, and School (Large Print 16pt).* ReadHowYouWant. com, 2011.

more than four chunks of information. Using the research of Mayer and Ware, there are two suggestions to remedy the split attention effect prevalent in the example slide. The first solution focuses on auditory working memory, and it is to reduce the presented information into smaller chunks and narrate the textual information instead of having the audience read the information on the slide. Mayer calls this process segmentation.[37] In essence, the presenter can segment the information in slide-based briefings by using animation to control the amount and timing of the information in the presentation. A second remedy, focused on visual working memory, is to use integrated data glyphs (a visual object that displays multiple data parameters) when using an information visualization.[38] Figure 13 presents an example of a comparison of integrated glyphs and non-integrated glyphs. In short, if the presenter wants to display multiple data parameters, then it is better to use a glyph similar to those on the left side of the figure, versus using a separate glyph for each individual parameter. Essentially, using integrated glyphs, minimal text, and narration takes advantage of the parallel processing capability of the human visual system. Thus, the audience has a reduced cognitive load making it easier for the audience to retain the presented information.[39]

Although these remedies are effective during the conduct of a presentation, the analyst still needs the ability to create useful information visualizations that reduce the cognitive load during when they are initially creating the presentation. Fixes for this problem are to study and apply pre-attentive processing, the Gestalt principles, and color selection to a visualization during the presentation design phase.[40]
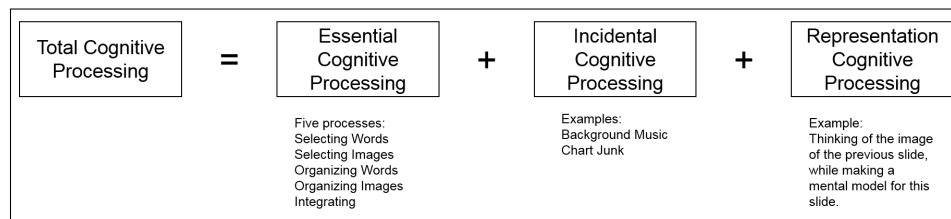

Total Cognitive Processing	=	Essential Cognitive Processing	+	Incidental Cognitive Processing	+	Representation Cognitive Processing
		Five processes: Selecting Words Selecting Images Organizing Words Organizing Images Integrating		Examples: Background Music Chart Junk		Example: Thinking of the image of the previous slide, while making a mental model for this slide.

Figure 11. Conceptual model of cognitive overload.

Pre-attentive Processing

In short, pre-attentive processing occurs when our sensory memory system can detect certain characteristics of a visualization before we engage our focused attention on that visualization.[41] Figure 14 shows some of the standard pre-attentive features an analyst can use to

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[37] Mayer and Moreno, "Nine ways to reduce cognitive load in multimedia learning", op. cit.

[38] Ware, *Information visualization: perception for design*, op. cit.

[39] Idem, *Information visualization: perception for design*, op. cit.; Mayer and Moreno, "Nine ways to reduce cognitive load in multimedia learning", op. cit.; Mayer, *Multimedia Learning*, op. cit.

[40] Ware, *Information visualization: perception for design*, op. cit.; J Scott Saults and Nelson Cowan. "A central capacity limit to the simultaneous storage of visual and auditory arrays in working memory." In: *Journal of Experimental Psychology: General* 136.4 (2007), p. 663; Nelson Cowan. "Visual and auditory working memory capacity". In: *Trends in cognitive sciences* 2.3 (1998), pp. 77–77.
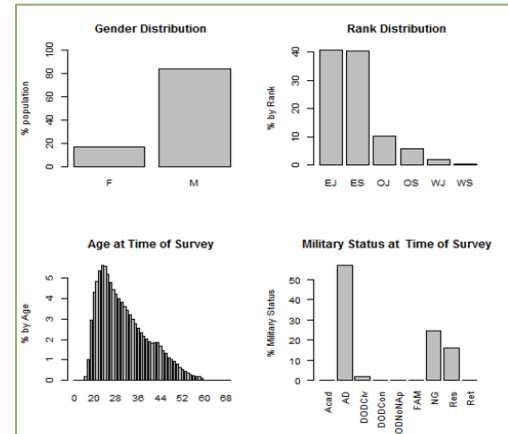
[41] Ware, *Information visualization: perception for design*, op. cit.; Cole Nussbaumer Knaflic. *Storytelling with Data: A Data Visualization Guide for Business Professionals*. John Wiley & Sons, 2015; Fry, "Computational information design", op. cit.; Munzner, *Visualization Analysis and Design*, op. cit.

- 572,366 total respondents for CY 2014.

- Gender
  - 477,353 males (83.4%).
  - 95,013 females (16.6%).

- Rank Group
  - 234,670 junior enlisted (EJ) (41%).
  - 228,946 senior enlisted (ES) (40%).
  - 57,237 junior officers (OJ) (10%) .
  - 34,342 senior officers (OS) (6%).
  - 11,447 junior warrants (WJ) (2%).
  - 2,633 senior warrants (WS) (0.46%).
  - 3,091 other (0.54%).

- Service
  - 332,334 Active Duty (AD) (58%).
  - 125,612 National Guard (NG) (22%).
  - 85,940 Reserves (Res) (15%).

Gender Distribution   Rank Distribution
Age at Time of Survey   Military Status at Time of Survey

EJ – Junior Enlisted   ES – Senior Enlisted OJ – Junior Officer OS – Senior Officer WJ – Junior Warrant WS – Senior Warrant   Acad – Academy Cadet AD – Active Duty
DODCiv – DoD Civilian DODCon – DoD Contractor DODNonAp – DoD Non-Appropriated Funded Personnel FAM – Family Member NG – National Guard
Res – Army Reserve Ret – Retiree

Figure 12. Example briefing slide with text and graphic.

Integrated glyphs

Nonintegrated glyphs

Direction ⟶ Arrow direction   Direction ⟶ Arrow direction
Temperature ⟶ Arrow color   Temperature ⟶ Circle color
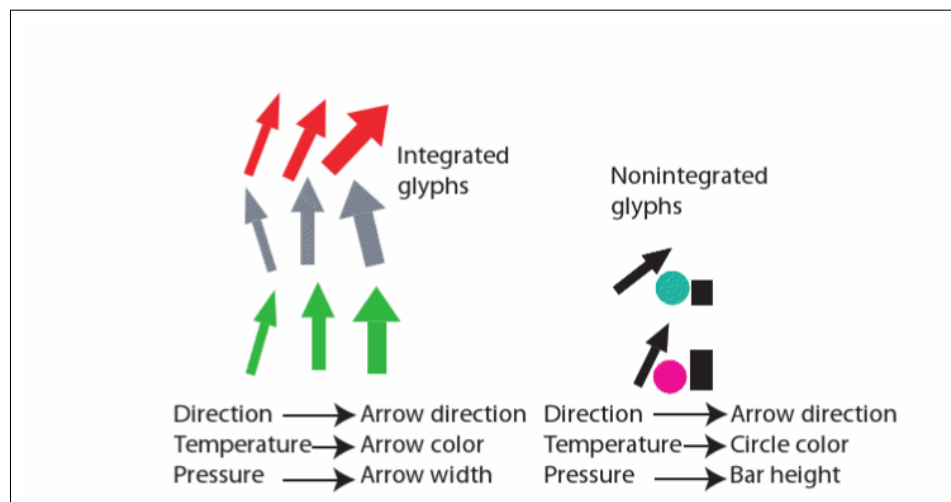Pressure ⟶ Arrow width   Pressure ⟶ Bar height

Figure 13. Comparison of glyph types adapted from Ware (2013).

prime the sensory memory system. The analyst can use four primary categories for these functions: color, form, position, and motion—for animated displays. Additionally, the functions of length and position are the most efficient for quantitative data; width, size, and intensity are less precise for quantitative data, and orientation, curved/straight, shape, enclosure, convex/concave, and added marks are best suited for qualitative data.[42]

A simple example will illustrate the advantage of using pre-attentive processing. Figure 15 shows a table of numbers that are all the same color. If the goal of this particular table were to look up the amount of ones in this table, this task would take some time due to a lack of features that would distinguish the ones from the rest of the numbers in the table. Also, the cognitive load of this table is high for the consumer of this information. Figure 16 addresses this problem by adjusting the intensity of the numbers other than the ones to a gray scale, thus making the task of counting the number of ones relatively straightforward and significantly reduces the cognitive load of the viewer.

Gestalt Principles

A group of German psychologists developed the Gestalt principles in 1912 to describe, in essence, how humans perceive patterns.[43] Still in use today, the principles of proximity, similarity, enclosure, closure, continuity, and connection can help the analyst to create visual order when separating relevant visual content from the visual clutter that does not add value.[44]

Proximity Principle. The proximity principle appears when visual marks that are relatively close in distance to each other seem to form a group. Figure 17 shows an example of this principle. On the left side of the figure, we can see two groups of dots that form a triangle and a square. In like manner, an application of this principle is shown by the dots on the right side of the figure. One group of dots is organized by columns, while the other group of dots is formed by rows.

Similarity Principle. The similarity principle appears when visual marks with the same color, shape, or orientation seem to form a group.Figure 18 shows an example of this principle. On the left side of the figure, we can see two groups of dots that form a triangle and a square. The blue dots in each shape would indicate that these marks are in a similar category, while the gray dots are not in this particular category. In like manner, an application of this principle is shown by the dots on the right side of the figure. The rows of blue dots would indicate a similar grouping that is different from the gray dots.

Enclosure Principle. The enclosure principle appears when visual marks form a group by making a box around them. Figure 19 shows an example of this principle. On the left side

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[42]Stephen Few. *Information Dashboard Design: Displaying data for at-a-glance monitoring.* Analytics Press, 2013.

[43]Knaflic, *Storytelling with Data: A Data Visualization Guide for Business Professionals*, op. cit.; Ware, *Information visualization: perception for design*, op. cit.

[44]Knaflic, *Storytelling with Data: A Data Visualization Guide for Business Professionals*, op. cit.
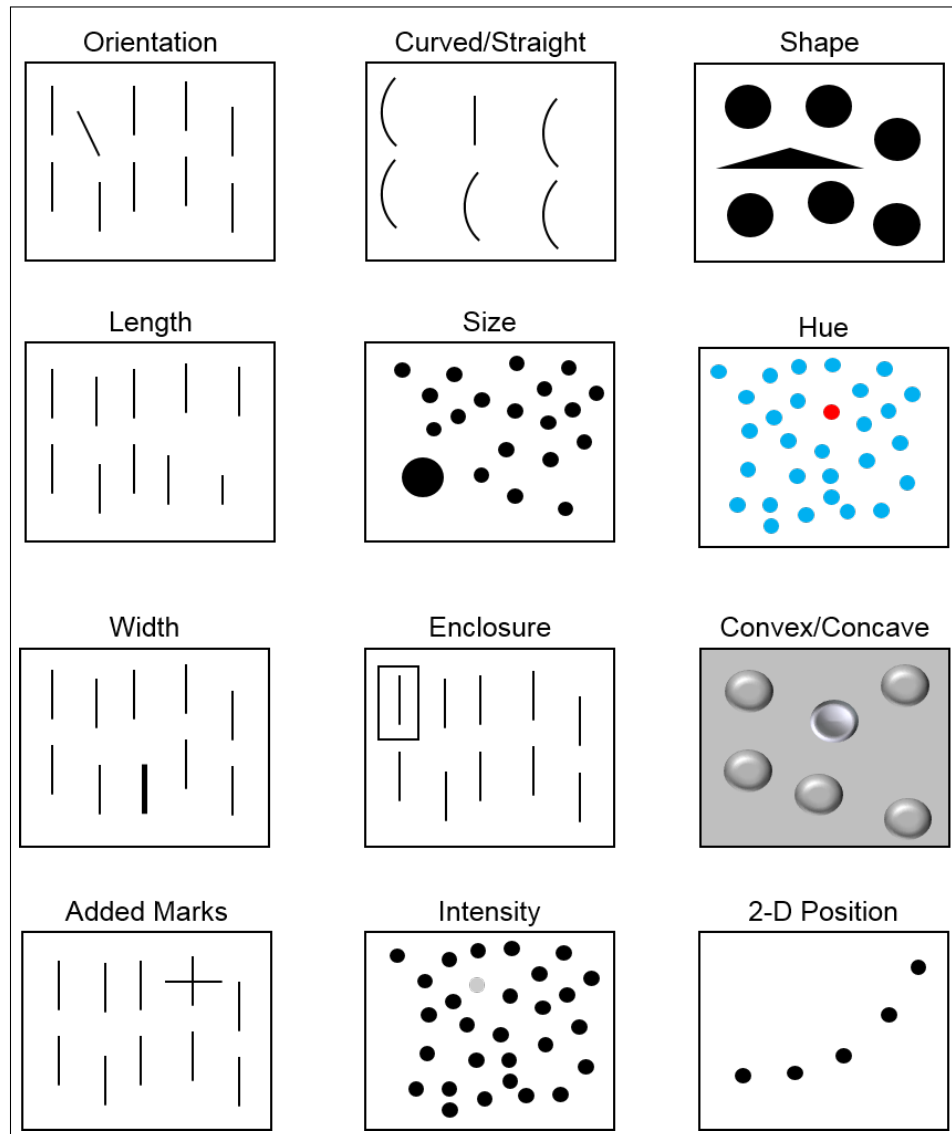
Figure 14. Examples of various pre-attentive processing features adapted from Few (2013).

of the figure, an example of the principle, the dots inside the rectangle form a distinct group. Similarly, on the right side of the figure, the application shows which data points fall within a particular range made by the rectangle.

Closure Principle. The closure principle appears when we try to mentally fill in missing information based on our current observation. Figure 20 shows an example of this principle. On the left side of the figure, the viewer will complete the image of the circle with continuous lines even though the circle in the figure has dashed lines . Likewise, on the right side of the figure, the graphic is missing a frame around it, which is the default of most charting tools, however the viewer will make a mental image of it to identify all the data belonging to the same chart.

18	19	16	13	13	21	16	13	9
4	23	8	2	12	22	17	21	18
8	11	17	14	5	16	6	25	21
11	19	13	12	10	1	6	22	13
7	1	4	2	4	17	4	18	22
6	16	1	12	24	22	25	1	20
9	9	1	3	23	6	8	4	11
1	20	22	25	19	24	1	23	14
4	4	7	23	5	5	18	20	17

Figure 15. Table of numbers with a high cognitive load and no pre-attentive processing features.

18	19	16	13	13	21	16	13	9
4	23	8	2	12	22	17	21	18
8	11	17	14	5	16	6	25	21
11	19	13	12	10	**1**	6	22	13
7	**1**	4	2	4	17	4	18	22
6	16	**1**	12	24	22	25	**1**	20
9	9	**1**	3	23	6	8	4	11
1	20	22	25	19	24	**1**	23	14
4	4	7	23	5	5	18	20	17

Figure 16. Table of numbers with a low cognitive load using intensity as a pre-attentive processing feature.
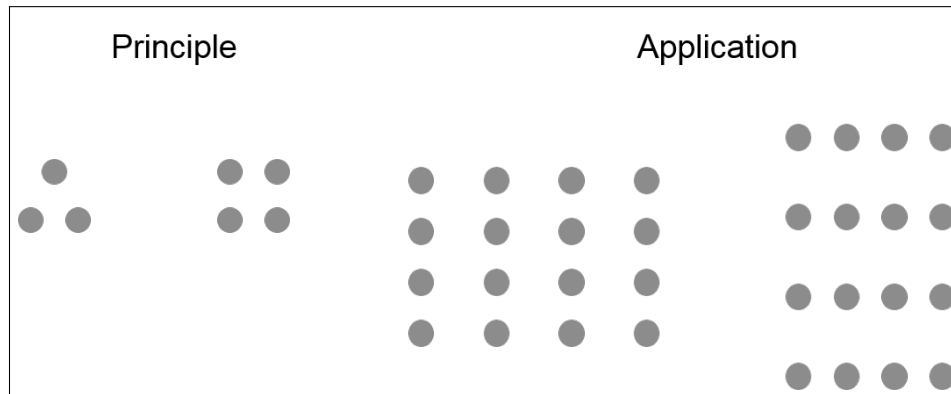

Figure 17. Example and application of the Gestalt proximity principle adapted from Knaflic (2015).

Continuity Principle. The continuity is similar to the closure principle in that we try to mentally fill in the space of information that is not currently present in the visual. The left side Figure 21, for example, shows that as we separate the shapes in (1), we would normally expect to see the shapes in (2). However, what might actually appear is (3). Comparing this example to the application in the figure, we can see that the bars align at the same point although the vertical axis is not present.
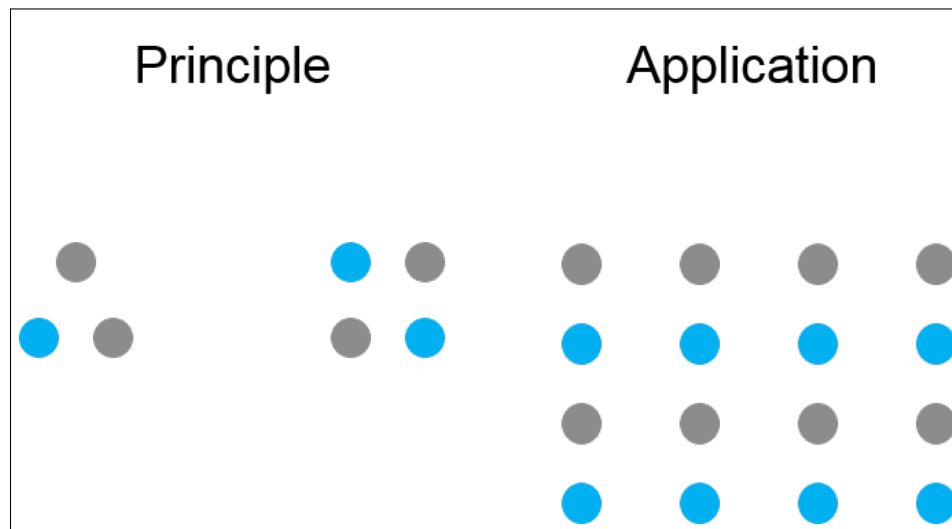
Figure 18. Example and application of the Gestalt similarity principle adapted from Knaflic (2015).
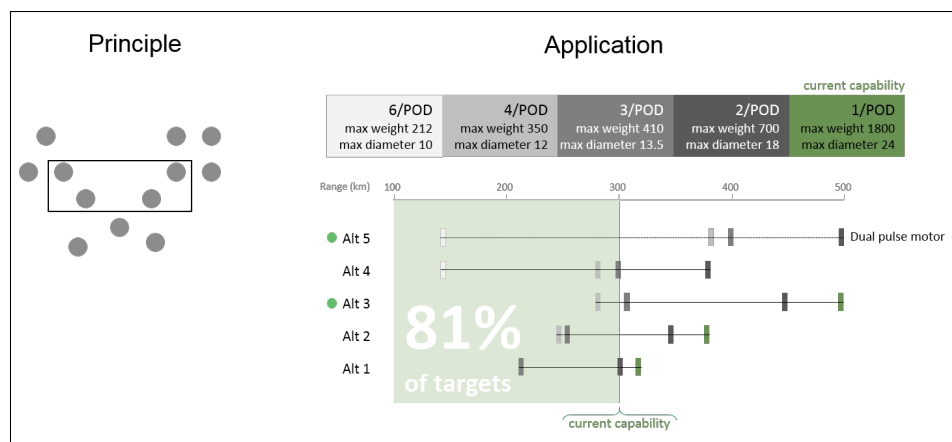

Figure 19. Example and application of the Gestalt enclosure principle adapted from Knaflic (2015).

Connection Principle. Linking objects together is an application of the connection principle. The left side Figure 22, is a simple example. The right side of the figure, however, shows how to utilize this principle in visualizing an argument of why the Fed would raise interest rates in this fictional example. The links establish the relationship between the conclusion that the Fed will raise interest rates and the premises that support (green colored boxes) or oppose (red colored boxes) this conclusion.
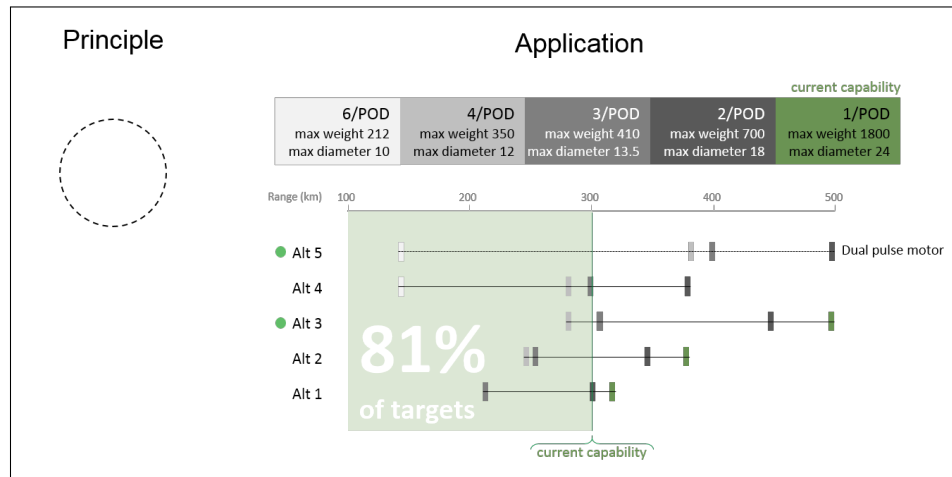
Figure 20. Example and application of the Gestalt closure principle adapted from Knaflic (2015).
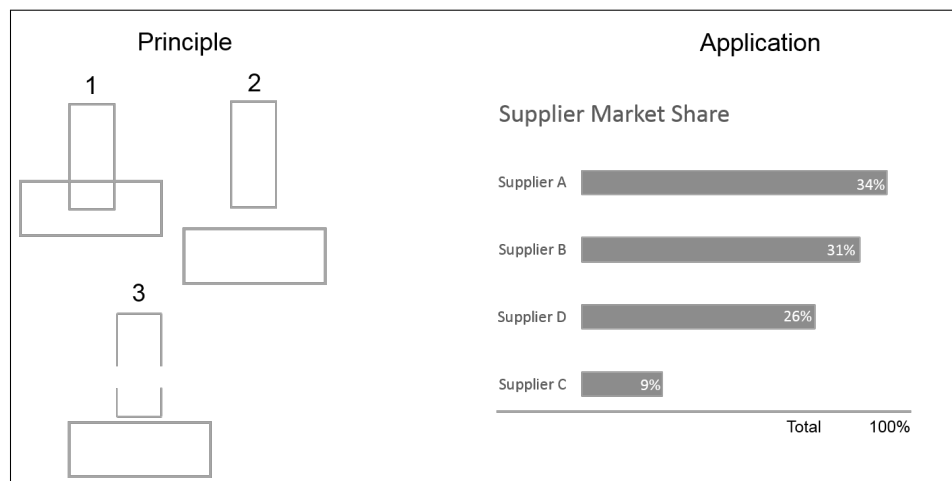

Figure 21. Example and application of the Gestalt continuity principle adapted from Knaflic (2015).

Visualization Design Process

According to Bostock, "Design is a search problem."[45] In other words, to create a useful visualization, you must understand that it is a product of a design process and it must serve a function that adheres to certain principles. Although this is simple in principle, the challenge is what approach do you take to choose the correct visualization idiom from the vast consideration space of known idioms? The diagram from Munzner (2015) illustrates this challenge, and we show it in Figure 23. Mainly, to select a good design, you must consider a wide variety of other potential solutions as indicated on the left. Usually, however, most inexperienced analysts only have a small known sample space to choose from which

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[45]Mike Bostock. *Design is a Search Problem. Presented at Bocoup Openvis Conference, Boston, MA.* 2014. URL: https://openvisconf.com/2014/.
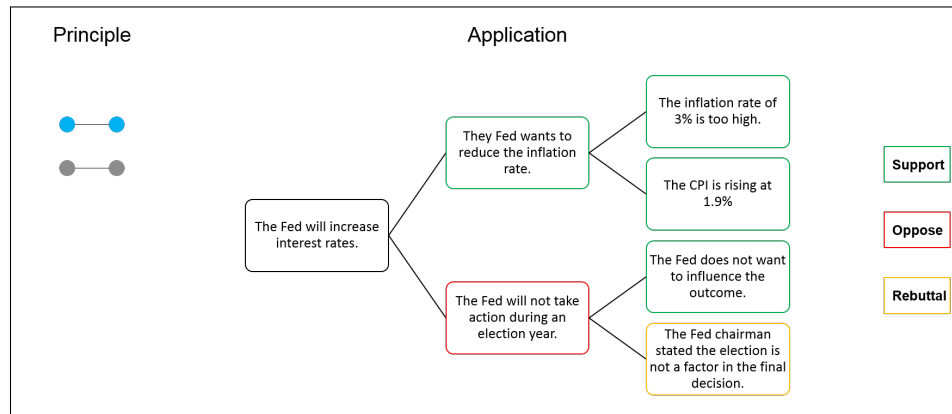
Figure 22. Example and application of the Gestalt connection principle adapted from Knaflic (2015).

could result in selecting an inadequate and ineffective visualization as demonstrated on the right-hand side of Figure 23.
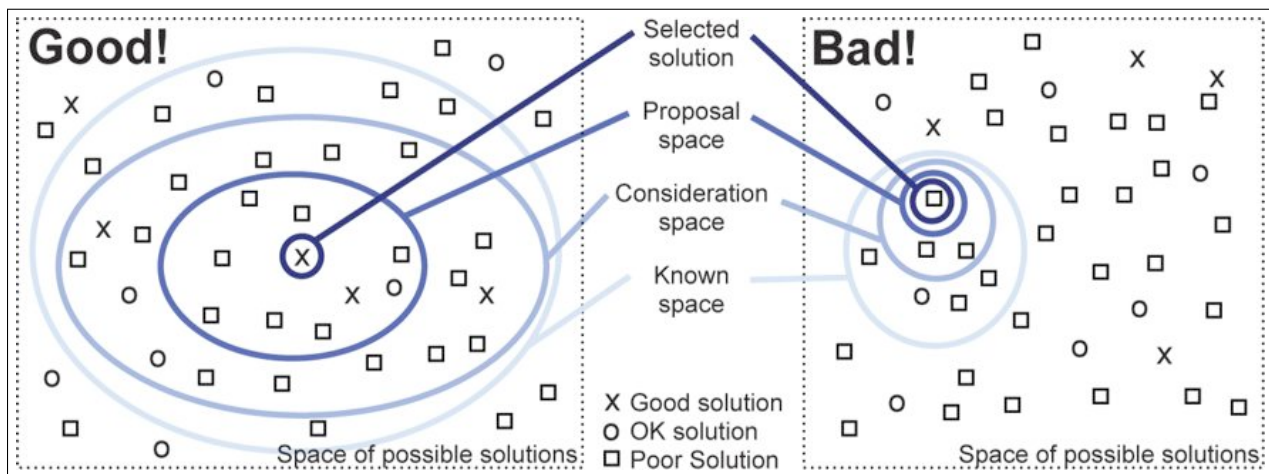

Figure 23. Graphic depicting visualization design choices from Munzner (2015).

Developing Visual Idioms

To reduce the risk of this happening, Munzner developed a visualization analysis and selection methodology that we will describe in the following section. Overall this process systematically analyzes the problem context for the visualization, the purpose of the visualization, the underlying data for the visualization, and the methods used to develop the final visualization. We also note here that this process can work for exploratory analysis—analysis used to discover key insights, and explanatory analysis—analysis used to explained the key insights derived from an exploratory analysis.

Similar to the design thinking process, Munzner developed a method to that takes a user-centered approach to visualization design. Figure 24 shows this construct. In this model, there are four design layers the analyst must consider: domain situation, data/task abstraction, visual encoding/interaction idiom, and algorithm. Since this is a nested model, the outermost layers feed information into the innermost layers. At the domain situation level, the analyst will conduct a process similar to the empathize step of the design thinking methodology. Next, in the data/task abstraction level, the analyst will define the required visualization tasks necessary to meet the customer's requirements. Finally, in the visual encoding/interaction idiom and algorithm levels, the analyst will ideate, prototype, and test different visualization idioms to determine the most efficient solution.
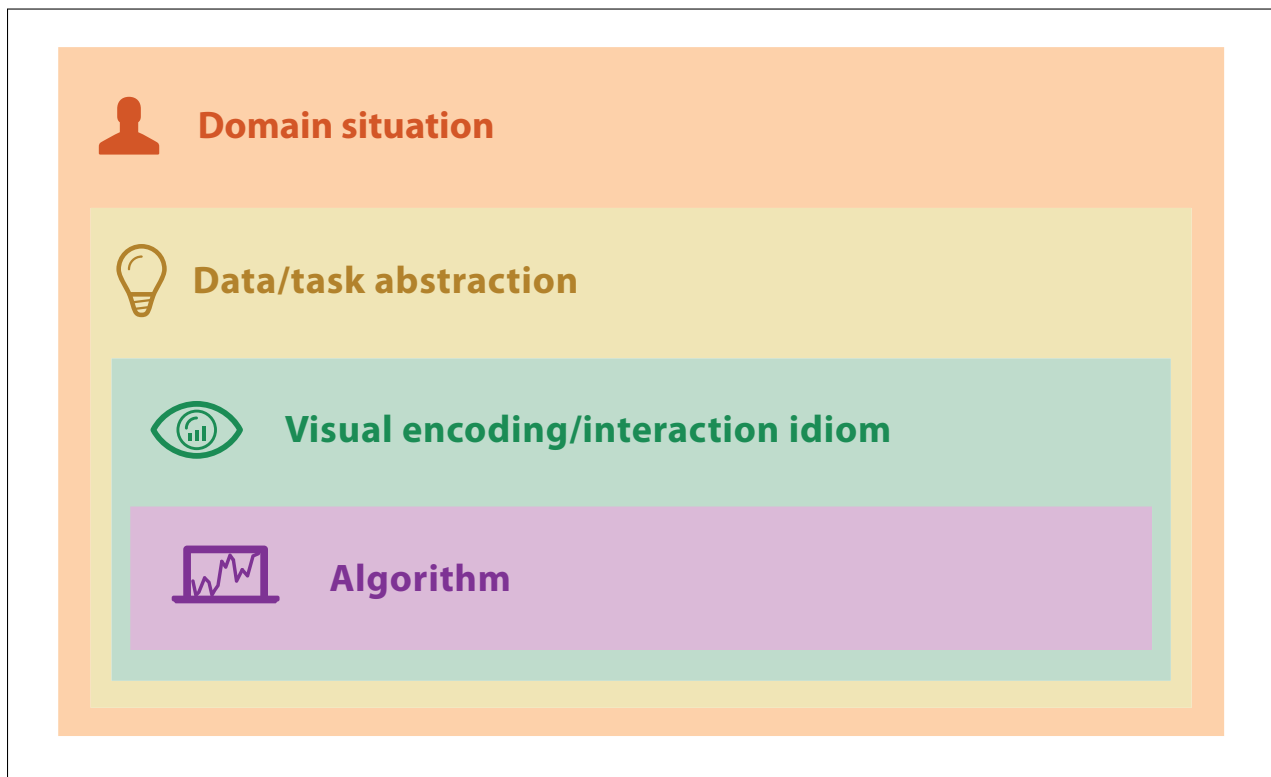

Figure 24. Nested model of vis design from Munzner (2015).

Understanding the problem context. At the outermost layer, the domain situation layer deals with primarily the problem of vetting the data requirements of the project's sponsors and the stakeholders. This layer is important because ultimately the projects that TRAC manage have various sponsors and stakeholders across the Department of Defense (DoD) that all have multiple interests. For instance, one stakeholder's primary interest may center around the operational aspects of the study and how the results could change our current doctrine, while another stakeholder may focus on how the data results in effect cost decisions. In this layer, the analyst will conduct a method similar to the measurement space process. Specifically, the analyst will determine the various data use requirements for each stakeholder and develop the appropriate visualization for the user.[46]

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[46]Munzner, *Visualization Analysis and Design*, op. cit.

Understanding the purpose of the visualization and the underlying data. The next layer is labeled data/task abstraction. At this level, the analyst is trying to produce the best visualization that meets the user's requirements. Hence, the analyst must focus on why the user needs a visualization and what data is available to produce the visualization. To put it another way, the current form of the data the user possesses does not provide the appropriate information to answer their questions. Figures 25 and 26 show the details of an approach developed by Munzner.

Why do we need the visualization? Starting with Figure 25, the analyst has a method to think about the specific requirements of the domain situation layer in Figure 24 in a more abstract way. For instance, one stakeholder may have a requirement to determine the association of one item characteristic to another. Similarly, another stakeholder may have a requirement to find a correspondence between two factors of interest. Initially, these two requirements may seem different, however, when viewed at a more abstract level, the analyst can determine these tasks are the same in that the users need to compare values between two item attributes.

Figure 25 shows that the user breaks down the why task into actions and targets. On the left-hand side of the figure, the highest-level action is to analyze the data. This analysis is further broken down into two sub-actions of consume and produce. In the consume action, the analyst will usually discover insights into the data in an exploratory analysis and present those insights in an explanatory analysis. There are times someone would just analyze data for their consumption, thus the enjoy task. The produce task is an action carried out before use, and the most common sub-action is to derive a visualization from of the data from what is most likely a table. Next, in the middle level of the left-hand side, the search action details the method in which the analyst or last user of the data will interact with individual items within the data set. For example, if the location and the target are known, then the search function the user or analyst will do is a lookup. Conversely, if the location and the target are both unknown, the user or analyst will explore the data. Finally, the query action is the lowest level, and it involves three sub-actions: identify one target, compare multiple targets, and summarize all targets.[47]

Moving to the right-hand side of Figure 25, targets of all the data include: trends, outliers, and features. If the target is a particular attribute—a measurable property of the data, then the target could be a distribution or extremes of a distribution for one attribute; a target could also be a dependency, correlation, or similarity for multiple attributes. Targets for network data include the topology and the network paths. Finally, spatial data targets focus on shape. A key aspect of this particular section of the analysis is to think of each action and target as a pair. In other words, each action of the analysis should correspond with a specific target. For example, you may want to present correlations, discover a distribution, explore topology, summarize features, identify outliers, etc.[48]

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[47]Ibid.

[48]Ibid.

What data do we have available? Figure 26 shows us the scope of data an analyst can use to create a visualization. The left-hand side of the figure displays types of data, types of datasets, and the availability of the datasets. In general most datasets an analyst with work with are tables, networks, trees, fields, geometry (spatial), cluster, lists, and sets. These datasets mostly contain five types of data: items, attributes, links, positions, and grids. The data sets could be available as either a static flat file or a dynamic stream or feed. The right-hand side of the figure details the types of attributes for the data items. These attributes are either categorical for qualitative data or ordered for quantitative data. The ordering of the data is either sequential, diverging, or cyclic.[49] In short, the type of data available can either expand or limit the analyst's capability to produce a particular kind of visualization.
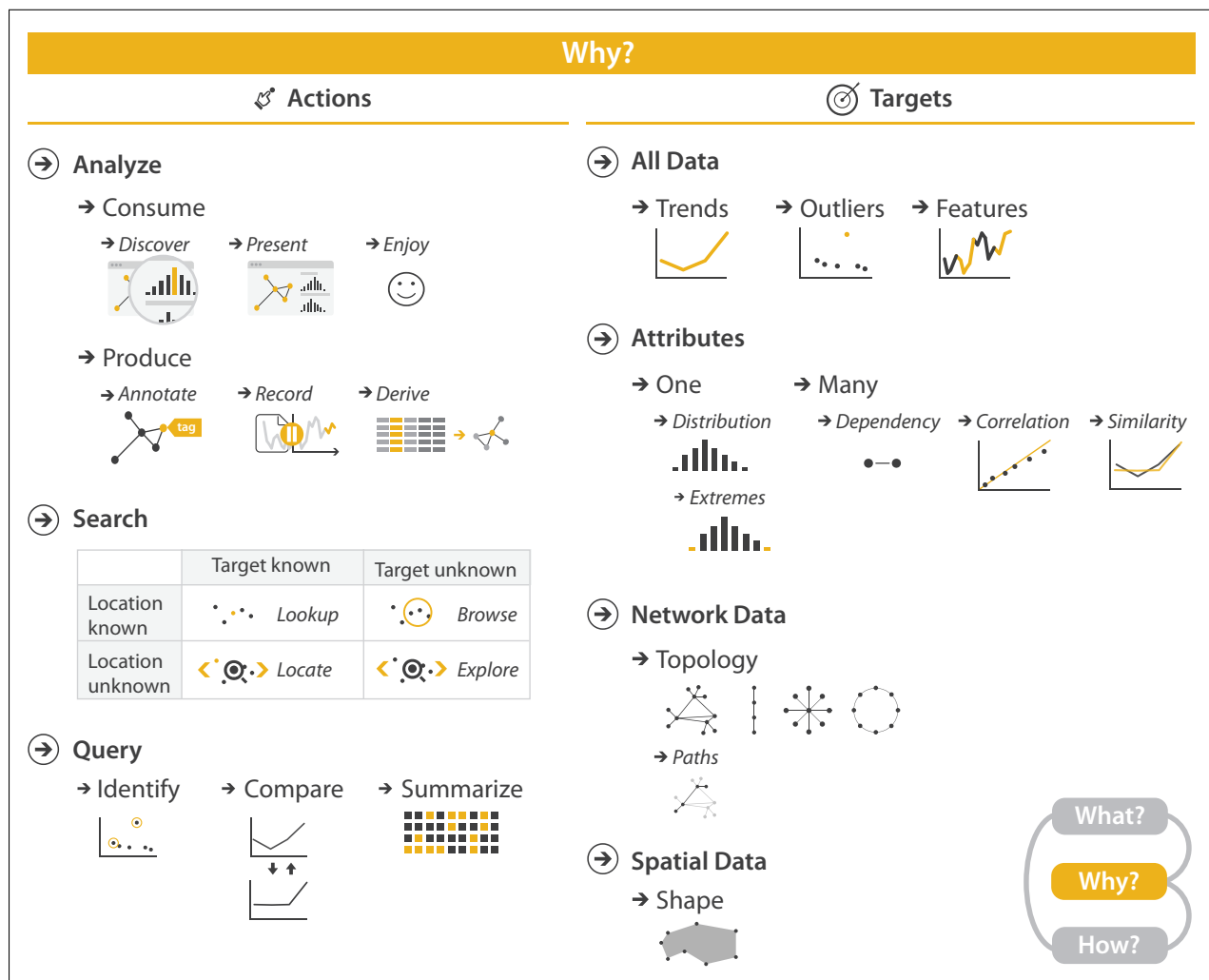

Figure 25. Why are we using this visualization from Munzner (2015).

Understanding the process to create the final visualization.
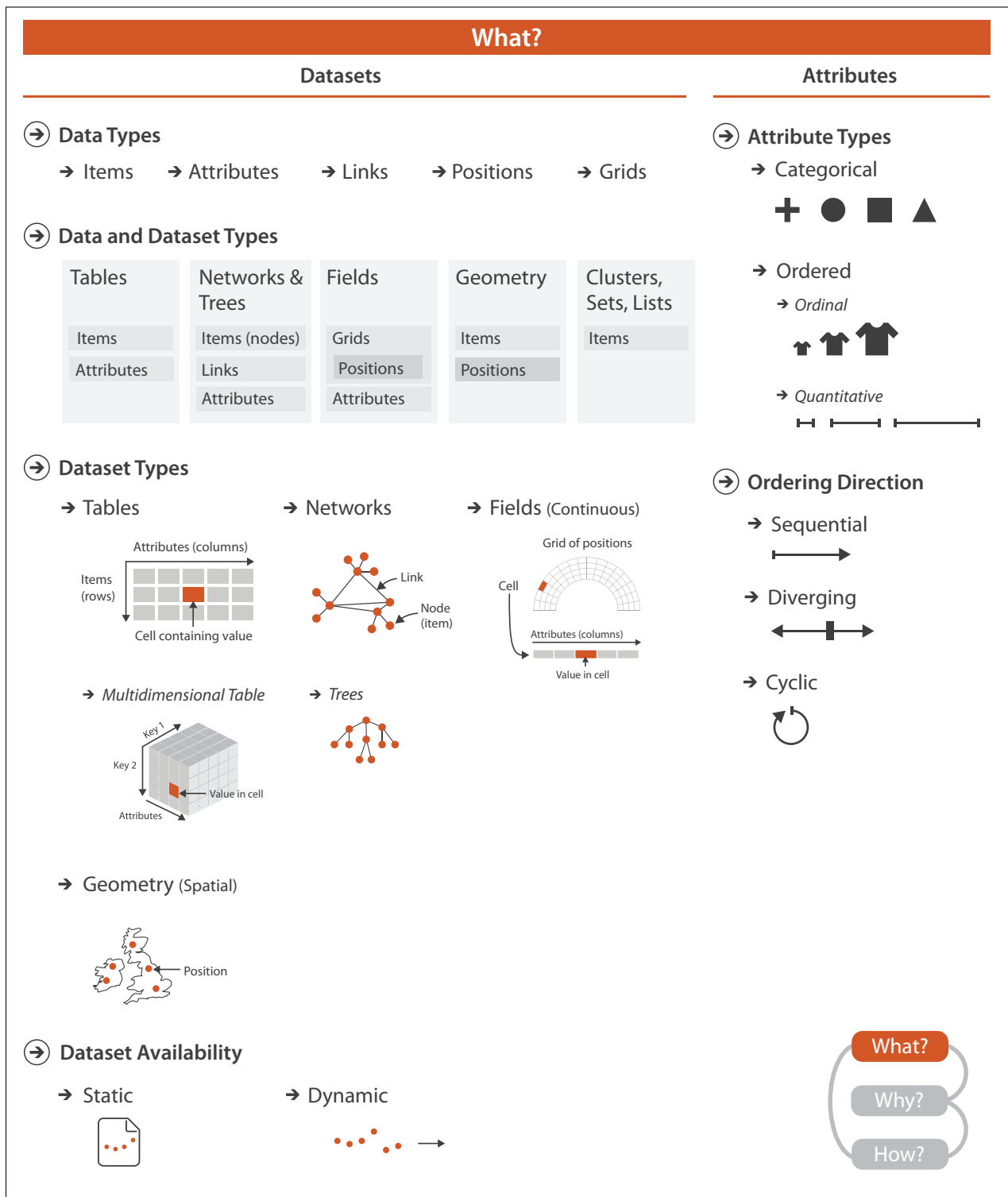
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[49]Ibid.

Figure 26. What types of data to visualize from Munzner (2015).

How to design the visual idioms? The final two layers of the model, visual encoding/interaction idiom and algorithm, deal with the specifics of how you will design your final

information visualization. In this section we will primary focus on the visual encoding/interaction idiom layer, because the algorithm layer focuses primarily on evaluating computational complexity. It is important, however, for the analyst to have a working knowledge of the visualization tools they use and how the algorithms work when deciding to create a particular visual idiom. Figure 27 presents the methods that the analyst can use to create the various visual idioms. Starting at the top left of the figure, the analyst has essentially two ways to encode data: arranging and mapping. There are five ways to arrange data: express values; separate, order, and align regions of data; and use spatial data. The analyst can map the categorical and ordered attributes of the data through color, size, angle, curvature, shape, or motion. Next, in the manipulate family of choices, the analyst can change, select, or navigate through different views of the data. Most of these methods apply to more interactive types of visualizations. Moving further to the right, the facet family has the options to juxtapose, partition, or superimpose, small multiple views of the data. Finally, in the reduce family of choices, the analyst can filter, aggregate, or embed other views and context information within the visualization.[50]

Types of visualization idioms. The various types of visualization idioms are too numerous and beyond the scope of this work. We will, however, discuss some key visual idioms and some tools that are useful in creating these visualizations.

Exploratory Analysis Visualization Development Exploratory data analysis employs a variety of techniques, mostly graphical, to gain insight into a data set; uncover underlying structure; extract important variables; detect outliers and anomalies; test basic assumptions; develop parsimonious models, and determine optimal factor settings. We use the R *lattice* package to illustrate exploratory data analysis.[51] Deepayan Sarkar developed Lattice to implement Trellis Graphics in R with some extensions. Lattice is a self-contained graphics system alternative to the R base graphics system and the R *ggplot2* package, which implements the Grammar of Graphics. Figure 28 depicts several Lattice functions by name: bar chart, box plot, kernel density plot, Cleveland dot plot, histogram, theoretical quantile-quantile plot, scatter plot matrix and scatter plot. Although we use R as our primary analysis tool, other tools can produce these same plots. The takeaway here is that the focus of these plots is on the **discovery** of insights, while the **presentation** of these insights are the focus of the next section.

Explanatory Analysis Visualization Development While visualization tools like R[52] and Tableau[53]produce stunning results, there is still some work on the part of the analyst when developing an explanatory visualization. The reason for this extra work is because

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[50]Ibid.

[51]R Core Team. *R: A Language and Environment for Statistical Computing.* R Foundation for Statistical Computing. Vienna, Austria, 2016. URL: https://www.R-project.org/; Deepayan Sarkar. *Lattice: Multivariate Data Visualization with R.* ISBN 978-0-387-75968-5. New York: Springer, 2008. URL: http://lmdvr.r-forge.r-project.org.

[52]https://cran.r-project.org/
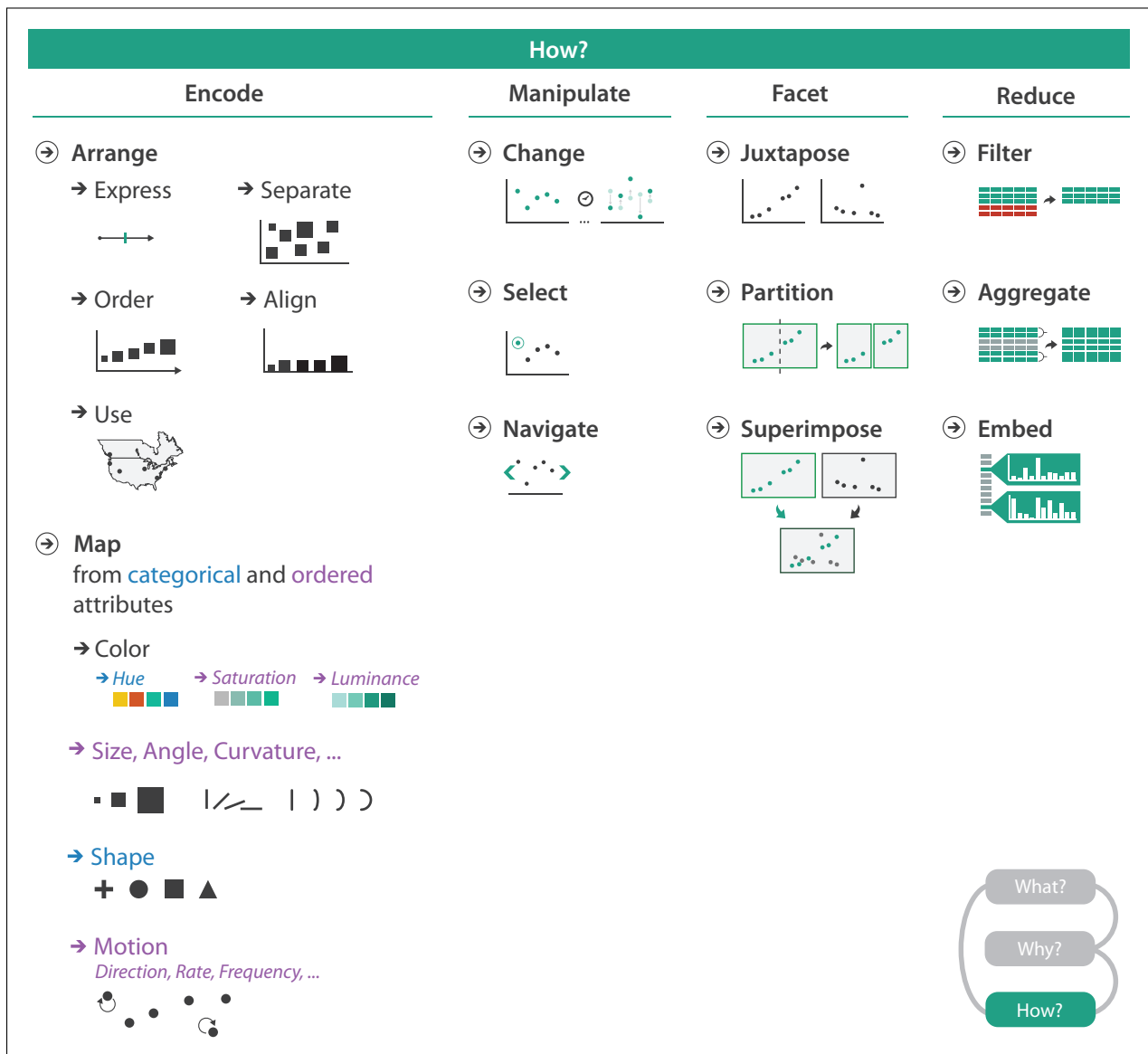
[53]http://www.tableau.com/

Figure 27. How to design the visualization from Munzner (2015).

explanatory visualizations have a tighter focus on the data than exploratory analyses. Thus, in most cases the analyst must modify their exploratory visualizations in a tool like Photoshop[54] or Inkscape[55] for most static idioms. D3[56] is a tool that an analyst can use to create web-based interactive visualizations.

Regardless, of their tool of choice the analyst must consider the effectiveness of any particular idiom with regards to how it will layout different marks—the basic geometric shapes (point, line, area, and volume) and the channels that control the appearance of each mark. Figure

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[54] http://www.adobe.com/products/photoshopfamily.html
[55] https://inkscape.org/en/
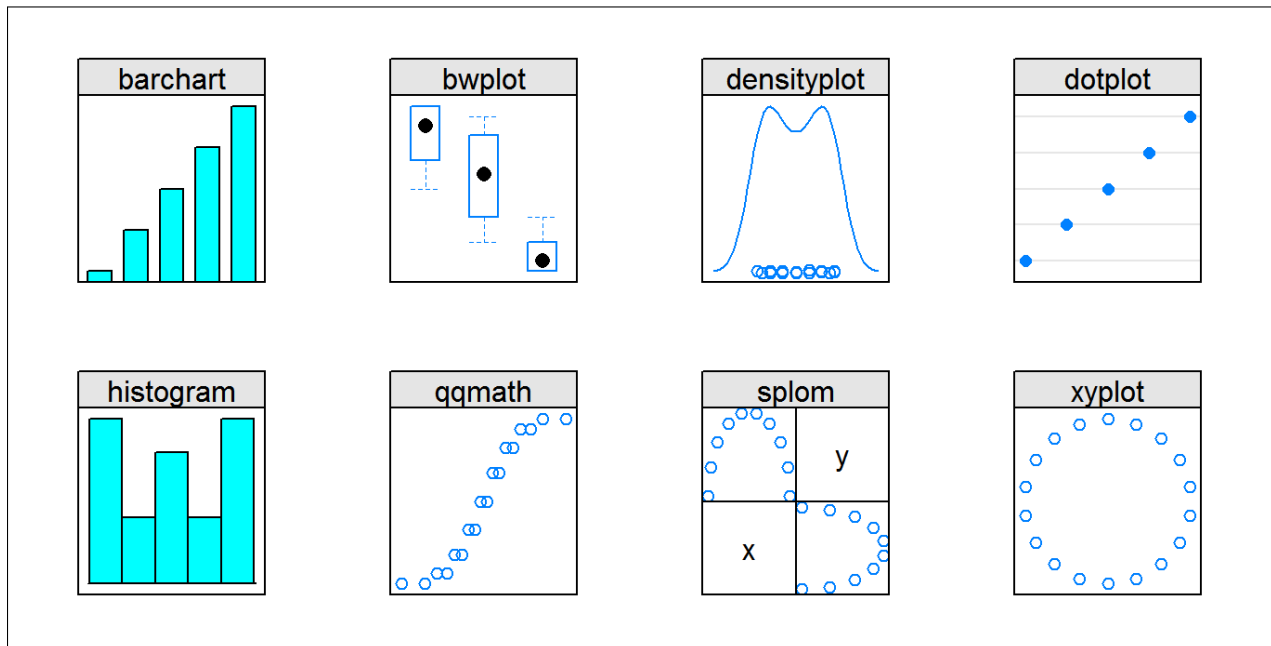[56] https://d3js.org/

Figure 28. Sample plots of select Lattice high level functions.

29 provides a reference for the analyst. The left-hand side of the figure lists in order of most effective to least effective visualization channels for ordered attributes. For instance, position on a common scale is the most effective channel for this type of attribute. Therefore, using a bar chart or dot plot that starts at a common point is a specific example. Area, as a magnitude channel, is further down the chart in the middle; this means that pie charts are not as effective as bar charts. At the bottom of the chart is volume and this means that 3D bubble charts, for example, are the least effective for explaining various insights into the data. Ultimately, this is because 3D abstract data occludes some important information.[57] The right-hand side of the figure show which visualization channels are the most to least effective for categorical data attributes. These channels from most to least effective are spatial region, color hue, motion, and shape.

Validating the visualization. A thorough analysis of the visualization requirement accomplishes two things. First, using a standard typology allows analysts to compare and contrast one visualization technique against another.[58] Second, using a standard typology assists analysts in determining the best software tool to utilize in making their visualization of choice. For instance, Figure 30 shows a comparison of two separate visualization idioms that produce a tree. This figure indicates that while these tools may take the same input data for the same purpose, the method in how to generate the final visualization differs.

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[57]Munzner, *Visualization Analysis and Design*, op. cit.; Ware, *Information visualization: perception for design*, op. cit.; Stephen Few. *Now you see it: simple visualization techniques for quantitative analysis*. Analytics Press, 2009.

[58]Tamara Munzer. *Visualization Analysis and Design Presentation for d3.U*. 2015. URL: https://www.cs.ubc.ca/~tmm/talks/minicourse14/vad16gi.pdf.
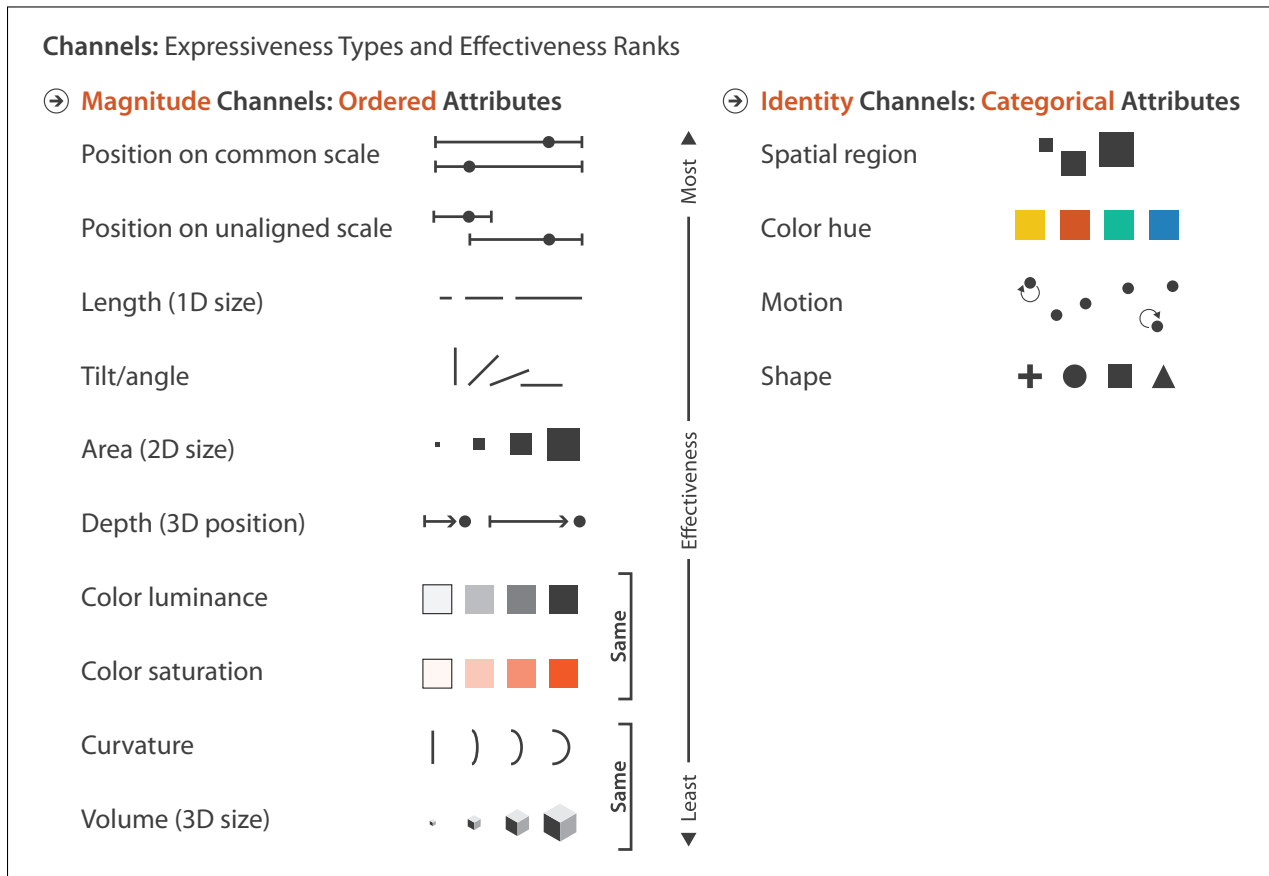
Figure 29. Visualization effectiveness chart from Munzner (2015).

These differences could ultimately affect how the user interacts with the data. Therefore, the analyst now has a way to compare these actions.

A second example of this analysis technique is shown in Figure 31. This figure illustrates how analysts can analyze nested tasks in producing a final visualization. On the left the input data consists of a tree and initially, the analyst needs to derive the quantitative attributes on each node. Next, the analyst will use these quantitative attributes to produce a filtered tree to summarize the topology of the network. Ultimately, this thorough analysis will help to ensure the resultant visualization meets the needs of the customer, and if it does not, then the analyst has a way to compare other methods to find one that better meets the customer's needs.[59]

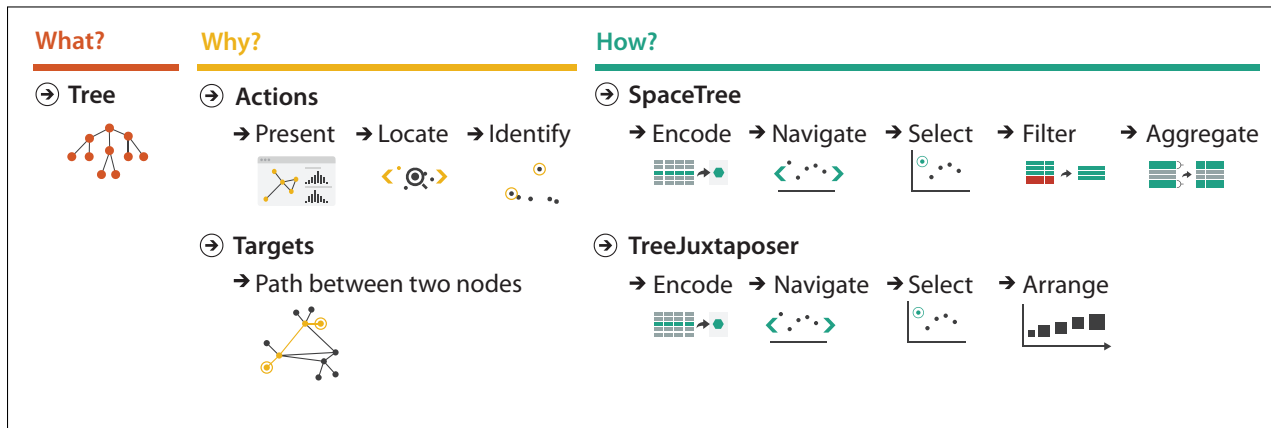[59]Munzner, *Visualization Analysis and Design*, op. cit.

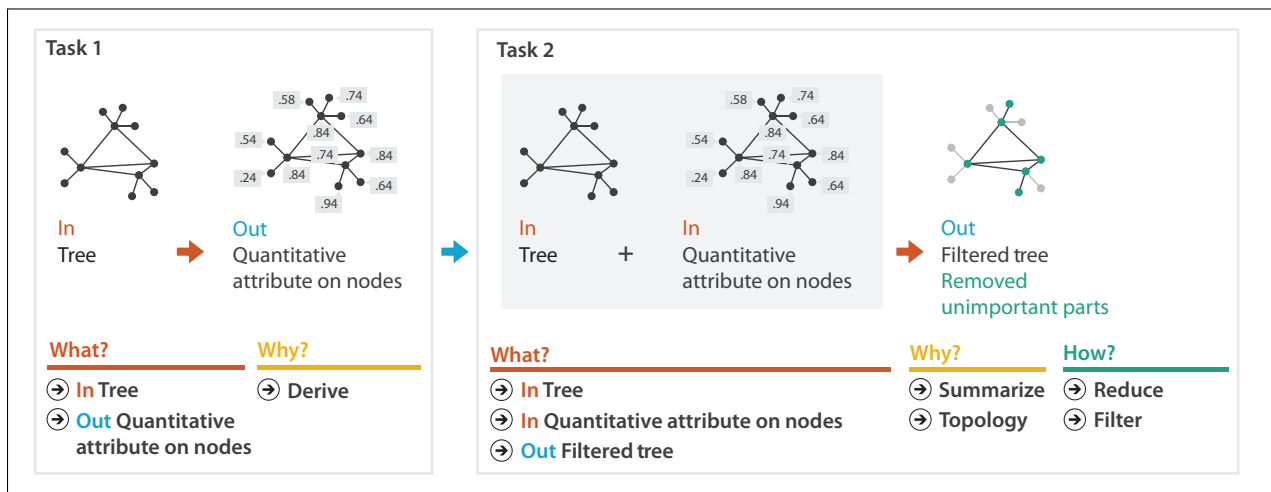**Figure 30. An analysis of two separate visualization idioms.**

Figure 31. Analyzing a chained sequence of visualization tasks.

General Presentation Principles

Developing the Analysis Story

Before presenting the analysis, the analyst must develop the overall story to tell to the senior leader. Pippin and Stoddard developed a macro-level planning framework for story design and presentation delivery shown in Figure 32.[60] A study of the figure shows that the lower level processes of assembling and tailor constitute preparing the presentation. During the presentation, the analyst will listen and dynamically adjust to the discussion and questions from the audience. Finally, analysts that master these skills will excel in the art of storytelling. Because the focus of this report is on the development of visualizations, we will discuss the assemble step of their process in further detail.

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[60]Bradley W. Pippin and Steven A. Stoddard. *Framing and Presenting Analysis to Senior Leaders. Presented at FA-49 Qualification Course, Fort Lee, VA.* 2016.

According to Pippin and Stoddard, the analyst should outline their presentation with a focus on a specific action or effect that the presenter wants to achieve during the presentation. Moreover, the analyst must tell a story and consider the different learning styles of the audience.[61] An advantage of using this framework is that it is consistent with the literature on developing effective presentations with a focus on the audience.[62] However, less experienced analysts may still require more details of how to craft a story beyond the information presented in this framework.

Atkinson does have a method to craft a story he details in his book *Beyod Bullet Points*.[63] We discuss the details of this method in Appendix B, but provide an overview of the method in Figure 33. A review of the figure shows the typical format of a story that has a beginning, middle, and ending. In the beginning, the storyteller presents the problem or challenge to the audience, the call to action that will help to overcome the goal, and finally the goal of the story. After Act I of the story is complete, the storyteller expands on how the call to action will help the audience to move from the problem state towards the goal that solves the problem. The takeaway here is that the storyteller can adjust the depth of their story depending on the audience and time available. Finally, the storyteller repeats the information presented in the beginning, but as a summary.

Eight Step Process. Our methodology to analyze a visualization is an iterative eight-step process. Figure 34 shows a visual representation of this process. We hesitate to really describe these as steps as you do not necessarily have to do these in order, but using these steps as a guide does provide some focus for those who are new to this process.

First, step 1 determines what are want to show or to put it another way, why are we even developing a visualization in the first place. This step is important because most inexperienced analysts just pretty much take their charts from their exploratory analysis (myself included) and just import them into the final briefing without much thought on why this is necessary. Next, step 2 and 3 help you to determine what kind of data do you have, and what kind of relationships can you show with this data? Afterwards, step 4 is when you then pick the best type of visualization that supports the relationships in your data.

When analyzing these first four in the context of design thinking, we empathize with the audience by determining what we want to convey to them (Step 1). Next, we define the visual problem by examining the key data elements we want to display and examining their relationships (Steps 2 and 3). After that, we ideate on how we want to visualize our data by

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[61]Ibid.

[62]Garr Reynolds. *Presentation Zen: Simple ideas on presentation design and delivery*. New Riders, 2011; M.S. Ramgopal. *Visual presentations: From Text Based Slides to Simple Powerful Diagrams in 3 easy steps*. Presentation Process. 2015. URL: http://www.presentation-process.com/; Knaflic, *Storytelling with Data: A Data Visualization Guide for Business Professionals*, op. cit.; Nancy Duarte. *Slide:ology: The art and science of creating great presentations*. O'Reilly Media Sebastopol, CA, 2008; Bartsch and Cobern, "Effectiveness of PowerPoint presentations in lectures.", op. cit.; Cliff Atkinson. *Beyond bullet points: Using Microsoft PowerPoint to create presentations that inform, motivate, and inspire*. Pearson Education, 2011; Alley, *The craft of scientific presentations*, op. cit.

[63]Atkinson, *Beyond bullet points: Using Microsoft PowerPoint to create presentations that inform, motivate, and inspire*, op. cit.
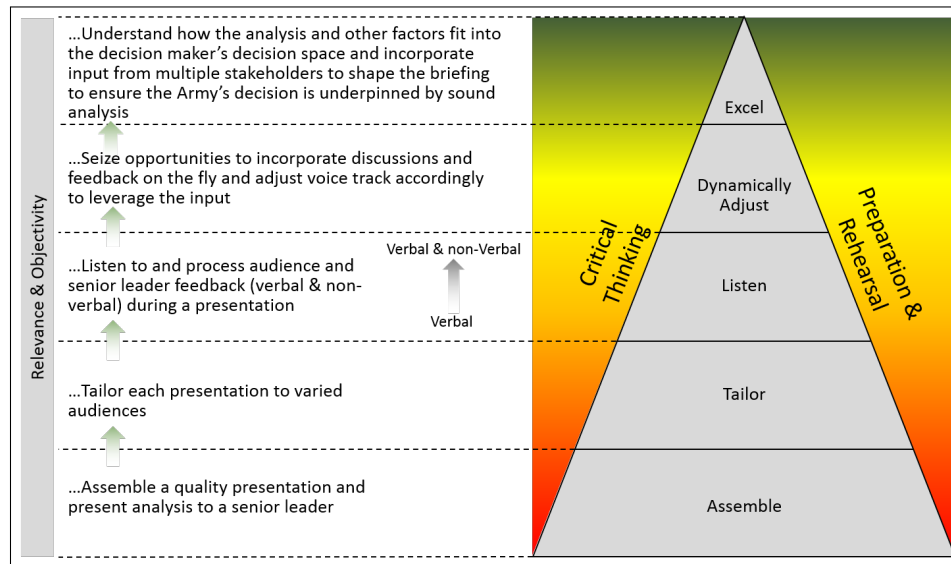
Figure 32. Conceptual framework for developing final analysis report for senior leaders. Reprinted from Pippin and Stoddard(2016).
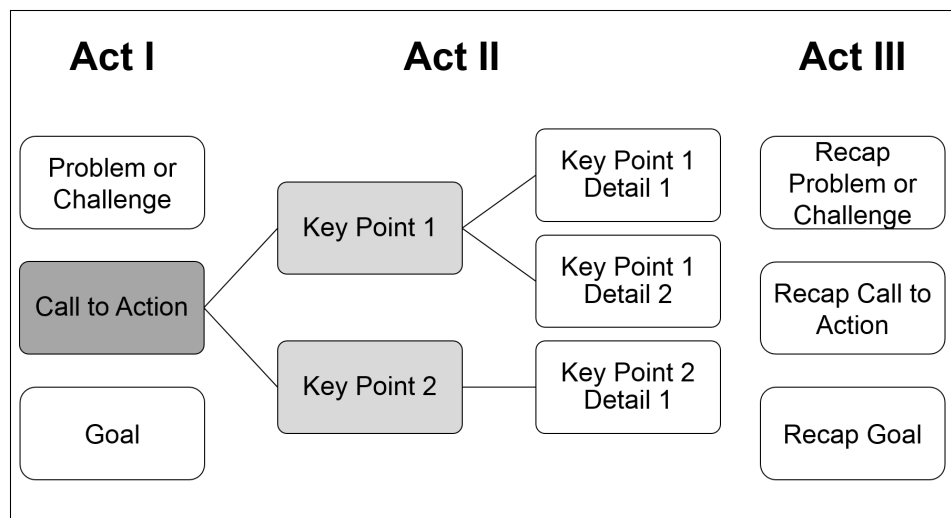

Figure 33. Beyond Bullet Points story struction adapted from Atkinson (2011).

choosing the appropriate visual idiom (Step 4). You can also think of these first four steps as the what and why of the Munzner method.

After we conduct initial planning of what vis we want to produce the next four steps describe the process of how to actually produce the visualization. Step 5 is helpful because making rough sketches of your graphic prior to using something more polished like R and Excel, help you to not get attached to a bad visualization. Next, step 6 is dependent on the previous steps in that if you know you want to develop a Sankey diagram, for instance, Excel 2013 is not the right tool for that job. Next, step 7 is the application of the key visual techniques we

will discuss later to help you focus the audience's attention to where it needs to be. Finally, step 8 allows for more collaboration and iteration to ensure we are using the right visual aid to support our point in the presentation. Again this entire process is iterative, because a visualization is a product of a design. Thus, it should have a specific function and a form that follows from that function.

From a design thinking perspective, we prototype our visualizations rapidly on the whiteboard and then in our appropriate digital tool (Steps 5 and 6). Aftewards, we test the messaging of our visual with others by highlighting the key focus areas and examining the visual aid to determine if it is functioning as we intended (Steps 7 and 8).
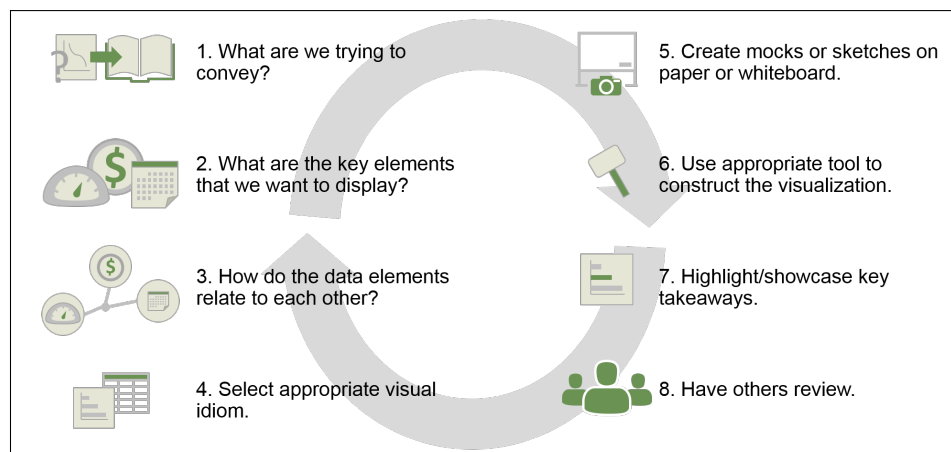

Figure 34. Eight step process to analyze and design visualizations.

Expanding on Step 8   When having others review the created vis, it is important to have a set of criteria in which to analyze the vis. Tufte provided the six principles below to serve as a guide for effectively presenting data.[64]

1. Show comparisons and contrast differences.
2. Show causality, mechanism, explanation, and systematic structure.
3. Show multivariate data.
4. Completely integrate words, numbers, images, and diagrams.
5. Thoroughly describe the evidence.
6. Analytical presentations ultimately stand or fall depending on the quality, relevance, and integrity of their content.

Using this information along with the Gestalt principles, we summarized this information into four key principles, shown in Figure 35, that are critical to just about any explanatory analysis. The first is choose the correct graph, table, video, visualization, or other visual aid as appropriate. The second is understand data-to-ink. Data-to-ink, a Tufte principle, is the analysis of the non-erasable ink that represents that data. Good graphics should subtract non data ink and emphasize the most important data ink. Non-Data-Ink – the ink that used

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[64]Edward R Tufte. *Beautiful Evidence.* Cheshire, CT: Graphics Press, 2006.

to present the actual data – should be deleted where possible to avoid drawing attention to irrelevant elements. The third principle, visual weight, is the ability of an element or region w/in a composition to draw attention to itself. Finally, use color to convey meaning as a contrast to necessary but non-essential items. This is most effective when only one element is the center of focus versus many elements. Emphasize everything, nothing stands out - Simple is sophisticated
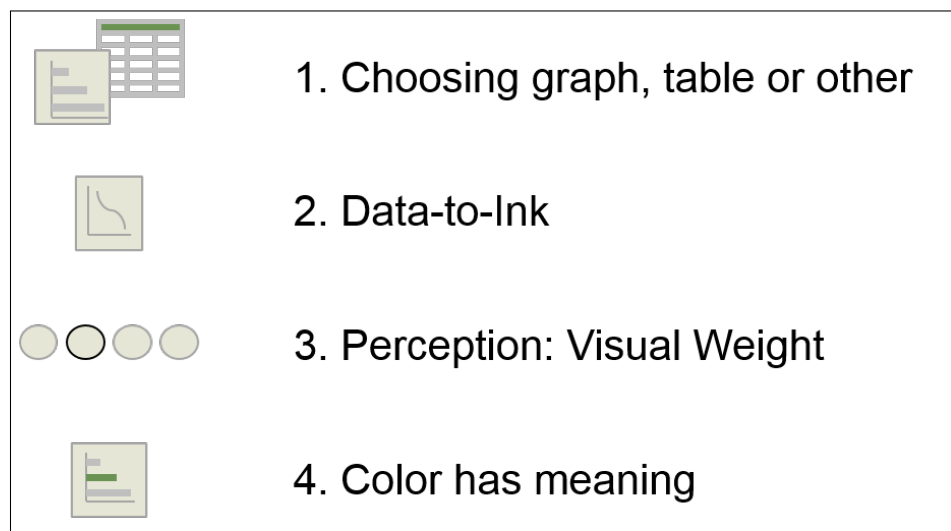

Figure 35. Four fundamental visualization principles.

Color Selection

The general rule when applying colors to encoded data is to remember that colors mean something—in other words they have a visual weight, and you need to use colors only when necessary.[65] However, the current TRAC style guide provides limited guidance on the use of the color palette. While there is an implication that the colors have meaning, the current style guide does not provide enough guidance on how and when to implement the various color shades. Also, the TRAC style guide lacks direction on creating branding items such as icons and backgrounds for TRAC various analysis and presentation documents.

To fill this capability gap we developed two separate color palettes for branding and analysis. Also, we developed guidelines to assist analysts on the appropriate contexts to use these color palettes.

Branding Palette. The branding palette will serve as the basis for establishing TRAC's brand with regards to developing icons, and other background colors in documents and presentations (see Figure 36 on page 39). We conducted an analysis of the color wheel using the site `http://paletton.com` to determine the best complimentary colors for TRAC to use when developing its brand. We discuss this analysis in detail in the next section.

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[65]Stephen Few. *Show me the numbers: Designing tables and graphs to enlighten.* Analytics Press, 2012; Knaflic, *Storytelling with Data: A Data Visualization Guide for Business Professionals*, op. cit.

Figure 36 shows the three colors of green, sand, and purple are still available, but our recommendations have more saturation and less brightness than the current TRAC colors. The addition of silver (top left), lemon grass (left side, second row), and brown (top right) increase possible ideas when developing icons, backgrounds, and other branding symbols. The result of which not only continues to maintain the quality of TRAC products but makes the look and feel of these products more modern.

Figure 36. Recommended color palette for branding TRAC icons and backgrounds of TRAC documents and presentations.

Branding Palette Application. Figure 37 shows some potential applications of the branding color palette. Some of these applications may require more colors, but this task is not too difficult provided we conduct a thorough analysis of the colors. These key application areas include but are not limited to:

- Web development (suggestion D3, JavaScript, HTML and CSS)— for ultimate customization and control in interactive solutions.
- Branding— Develop methodologies that capture TRAC's brand via colors and logos in a design conscious way.

- Style Guide— Creating a consistent way to utilize design and visualization techniques that convey the branding. Ultimately, this is the desire of TRAC leadership.
- Icon Library— Helps to maintain consistent messaging of ideas and methods used in TRAC analysis. Also provides a means to distribute developed icons across all the TRAC centers.
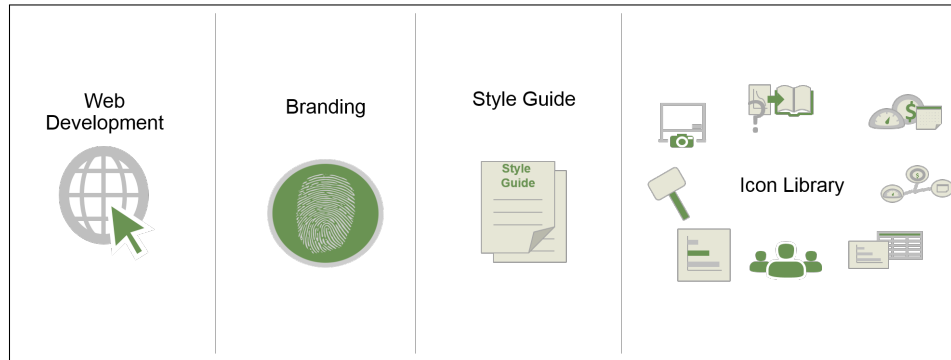

Figure 37. Potential applications of the branding palette.

Branding Color Analysis Methodology. Using the website `http://paletton.com`, we conduct two color wheel analyses to analyze the branding colors using a color wheel and other color tuning settings such as hue, saturation, brightness, and contrast. First, we run a color wheel location analysis of the current TRAC colors, with other colors of the same color group, but these new colors have a different position on the color wheel. Figure 38 on page 41 shows the result of the analysis for the current TRAC dark green color. The left side of the figure demonstrates the location of the current TRAC dark green on the color wheel. The current TRAC green is closer to the brighter edge of the color wheel shown by the highlighted arc on the inner green wheel. This placement on the color wheel increases the difficulty of projecting this color.[66] To remedy this situation, we adjust the saturation and brightness levels of the current TRAC green to a slightly darker hue as shown on the right side of Figure 38. The result of this adjustment provides more flexibility in the different shades and makes it easier to project.

The second analysis involves selecting supporting colors for the TRAC branding colors. Figure 39 on page 41 demonstrates an example of this process. In the figure, the primary color is the recommended TRAC dark green. Using a triad color combination with a distance of 30°between the secondary colors, we select the brown and purple colors. The sand color selection results from analyzing the purple color shades. The silver and lemongrass colors are the results of testing these colors with the other base colors of TRAC green, purple, sand, and brown.

Analysis Palette. Since Brewer et al. conducted extensive research on color palettes for analysis, we decided to implement their recommendation for the TRAC analysis palette.[67]

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[66]Duarte, *Slide:ology: The art and science of creating great presentations*, op. cit.

[67]Mark Harrower and Cynthia A Brewer. "ColorBrewer. org: an online tool for selecting colour schemes for maps". In: *The Cartographic Journal* 40.1 (2003), pp. 27–37; Cynthia A Brewer et al. "ColorBrewer 2.0". In: *WebWeb site: http://www. ColorBrewer. org/. Accessed June, 2016.* (2011).
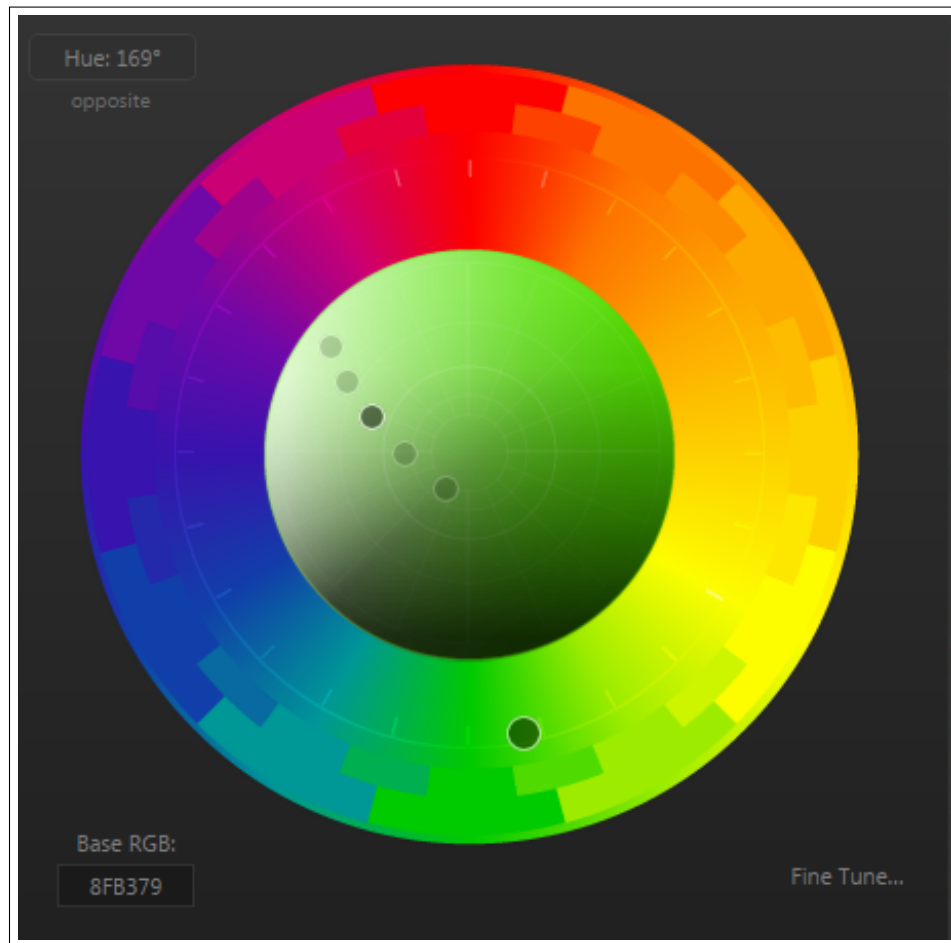
Figure 38. Comparison of the current TRAC dark green (left) and the recommendation for the new TRAC dark green (right).
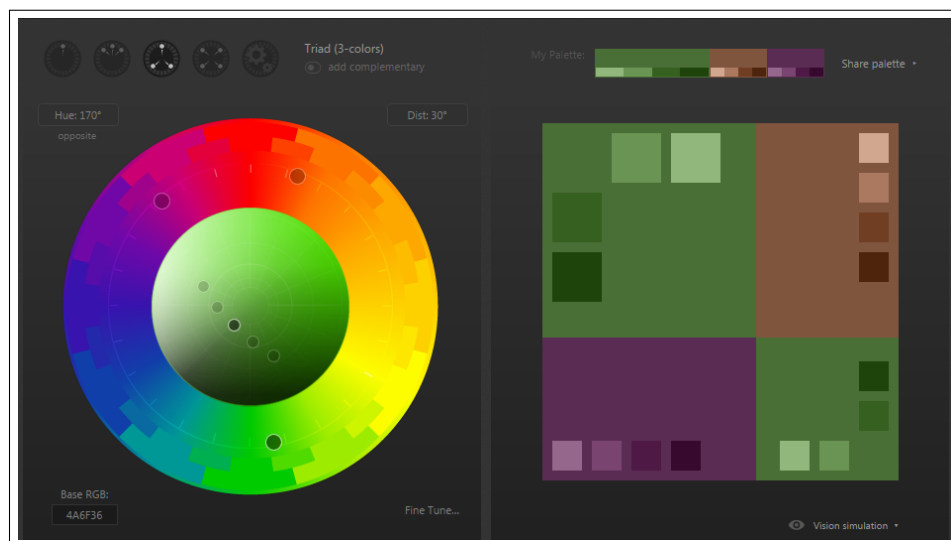

Figure 39. Screenshot of supporting colors for TRAC dark green.

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Chapter 3
Application of Visualization Techniques

In this chapter, we will demonstrate how to apply the principles discussed in the previous chapter. A key takeaway is that the focus of these slide makeovers should be on the application of the principles and not a particular chart or graphic.

Visual Transformation

In this section, we will transform a few slides from a brief given by Moten to the Army Resiliency Directorate during an In Progress Review (IPR).[68] We chose this briefing since it has the elements typically found in a TRAC presentation. The transformation slides use the *Assertion-Evidence* template with some minor branding modifications.[69] Each transformation slide contains a short headline title developed with the *Beyond Bullet Points* outline.[70]

Title Slide

Figure 40 on page 44 shows the current TRAC title slide format. Although this slide shows some information that helps the audience to know what the briefing is about and who is giving the briefing, there is some room for improvement in setting the right tone for the presentation. Figure 41 on page 45 shows the improved title slide. Similarly to the original slide, the new title slide contains the same title, location, and date information. In contrast to the first title slide, the addition of a supporting image helps to focus the audience's attention to the overall point of this presentation. Also, we added some branding colors and logos to the title slide.

Agenda Slide

The current agenda slide, shown in Figure 42 on page 46, does not help the audience link the information from the title slide to the current points of discussion. Additionally, most audiences know the general format of an IPR, so including the purpose and the bulleted lists of topics is redundant. Figure 43 on page 47 shows the transformation of this slide. Instead of using a bulleted list of items, we write a short headline at the top of the slide and use

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[68] Cardy Moten III. *Global Assessment Tool 2.0 Exploratory Analysis Final IPR. Presented to Army Resiliency Directorate, Crystal City, VA*. 2015.

[69] Alley, *The craft of scientific presentations*, op. cit.

[70] Atkinson, *Beyond bullet points: Using Microsoft PowerPoint to create presentations that inform, motivate, and inspire*, op. cit.

Figure 40. Current TRAC title slide.

supporting images that will focus on the two main themes of discussion, latent class analysis, and cluster analysis. An advantage of this new format is that we can use these images in later sections of the presentation to cue the audience on transition points. Also, the images provide the audience a visual reference on what the current point of discussion will entail.

Methodology Slide

The current slide, shown in Figure 44 on page 48 , requires the use of a legend to understand the various elements of the methodology. While the utilization of a legend is adequate for this small study, this approach to presenting the methodology can become complex. From a visual perspective, there are too many data-to-ink aspects that do not help to focus the audience on which information to start and end with on the slide. Also, the colors have no meaning and have equal visual weight. Our transformation for the methodology slide involved using a Unified Modeling Language (UML) class diagram to present the methodology. Shown in Figure 45 on page 49, the top line of the diagram is a short title for the methodology step. Next, we list the inputs for the step. We can also insert the particular study issue by listing
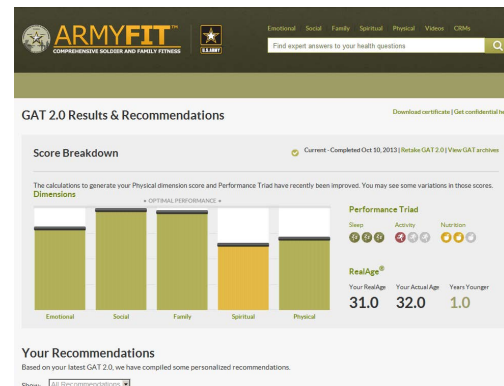
Figure 41. Updated TRAC title slide.

these items after the inputs. Finally, we list the outputs for this step under the blue dividing line.

Example Analysis

Finally, we will analyze and transform a short section of analysis from the IPR briefing. The intent of this section of the brief was to explain to the audience why latent class analysis is a favorable methodology to model resiliency. Afterward, we discussed the results of the latent class analysis using a classification table to show the audience the key similarities and differences between the selected latent classes.

General Model Description

Figure 46 on page 50 shows the information briefed to the audience. The slide title is a question intended to prompt the audience to think of the reason the study team chose to use latent class analysis. While the utilization of a question as a title slide is not wrong, this slide title does not provide enough context on what latent class analysis is modeling. Next, the green box contains the reason for the use of latent class analysis. There are several issues, however, with this box. First, the long text increases the cognitive load for the audience because the presenter is narrating other information while the audience is reading the text. Next, the green color does not have a particular meaning. The bold font also does not aid in understanding the information. The corresponding graphic in the middle of the slide does

Figure 42. Current TRAC agenda slide.

not support understanding of the textual information because it does not show a latent class model diagram. Also, the yellow box at the bottom also increases the confusion for the audience as this most likely will be the first point of focus for the audience. The color and the bold font also have the same issues discussed previously with the green text box. This slide also wastes too much ink on non data elements.

Figure 47 on page 51 shows a fix for this slide. The title is specific on why the study team chose latent class analysis. Additionally, the supporting graphic is a simple diagram that the briefer can discuss with the audience to give them a simple understanding of the concept behind latent class analysis. In subsequent iterations, we can improve this slide by removing the frames around the models and moving the arrow in the middle. Compared to the original slide, however, this slide dramatically decreases the cognitive load for the audience and consequently increases the potential for the audience to comprehend the information presented to them.
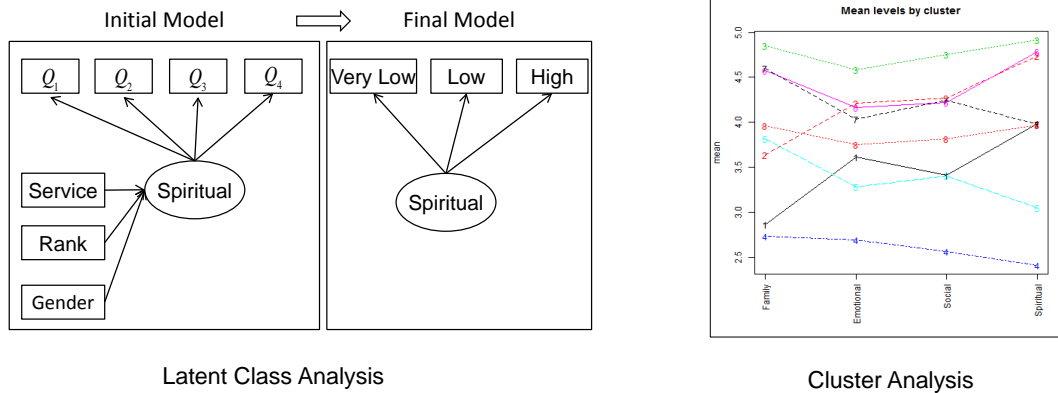
Figure 43. Updated TRAC agenda slide.

Model Classification Table

After explaining the reason to use latent class analysis, the study team briefed the results of their model using a table shown in Figure 48 on page 52. With regards to analyzing the table, we first determined that a table is an appropriate presentation idiom to use because the briefer wants to audience to look up specific values on the table to compare the data. The problem with the current format of the table, however, does not augment this process for the audience because the green color does not provide any specific meaning, and the briefer did not highlight the specific items of interest for the audience. Moreover, the title also does not focus the audience on where to look for this information. Finally, the abbreviations are too small for the audience to read.

To address these issues, we developed a series of slides shown in Figures 49 - 52 on pages 53 - 54 respectively. To start, we inserted a graphic similar to the model shown in Figure 47. Since the audience will have a recent memory of this construct, it will help them to understand how we developed the final model. Afterward, we improve the table by removing unnecessary data-to-ink objects such as the table lines and green color. At the same time, we color the important text green in color and color the remaining classifications gray in color. We also spell out the previously abbreviated categories and the slide title provides the necessary context for the audience to follow. Finally, we developed three separate tables with the appropriate titles and data highlights to keep the audience focused on those specific aspects of the analysis.
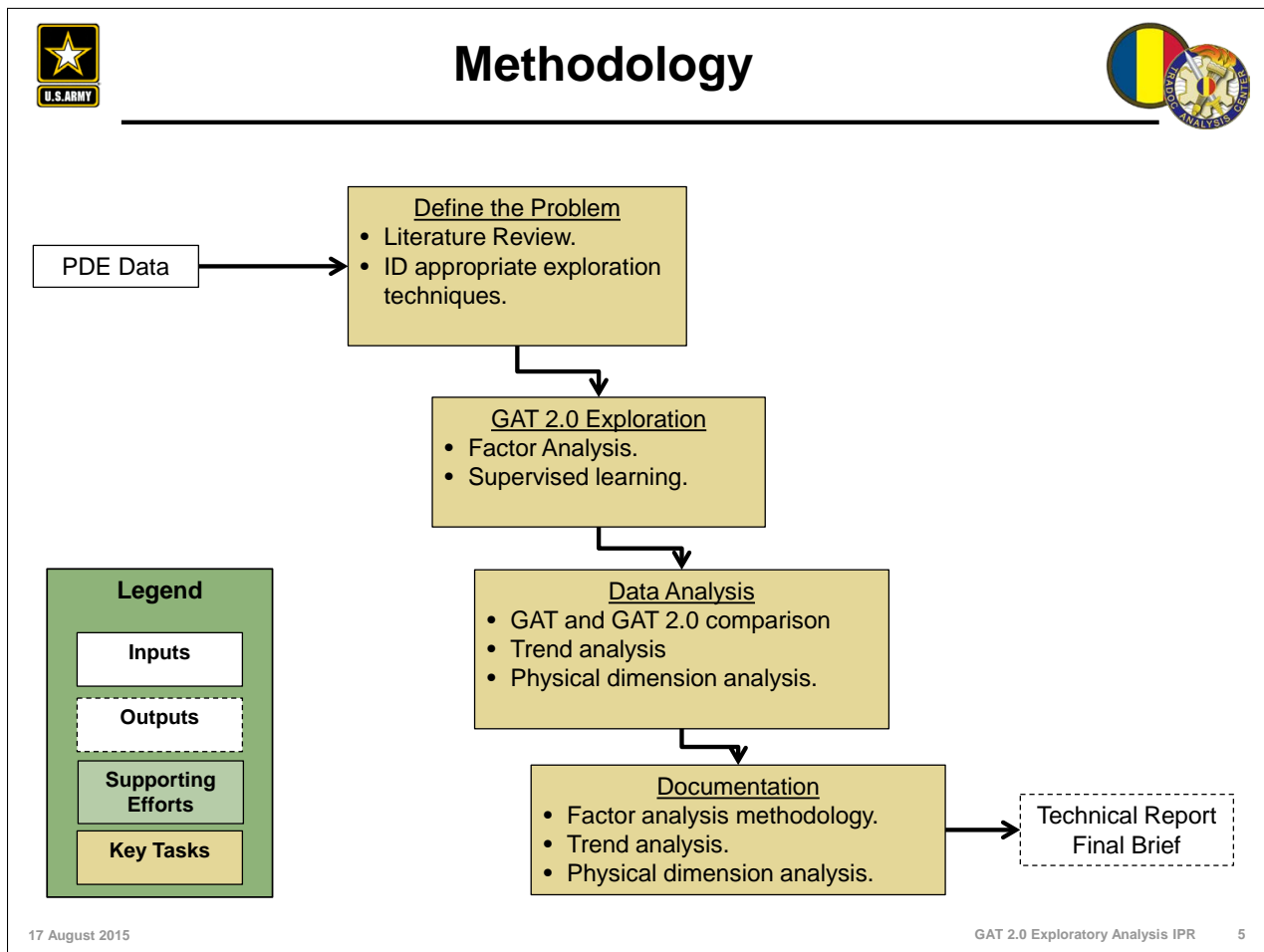
Figure 44. Current TRAC methodology slide.

We will solve this problem through a data-driven approach to modeling resiliency.

Phase I: Define the Problem

Literature Review.
ID appropriate explration techniques.

Rescoped problem statement

Phase II: GAT 2.0 Data Exploration

Latent Variable Modeling.
Supervised Learning.

Resiliency Latent Variable Model.
GAT Data Clusters.

Phase III: Data Analysis

GAT 1.0 and GAT 2.0 Comparison.
GAT Trend Analysis.
GAT Physical Dimension Analysis.

Identified GAT trends.
GAT Physical Dimension Scoring Model.
Technical Report.

Figure 45. Updated TRAC methodology slide.
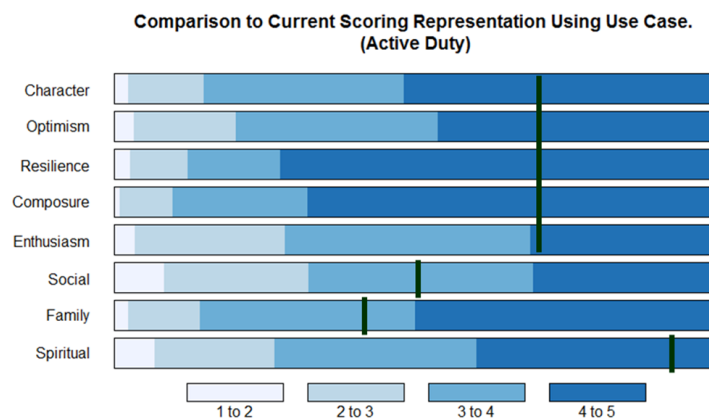
Figure 46. Current TRAC body slide with take boxes.
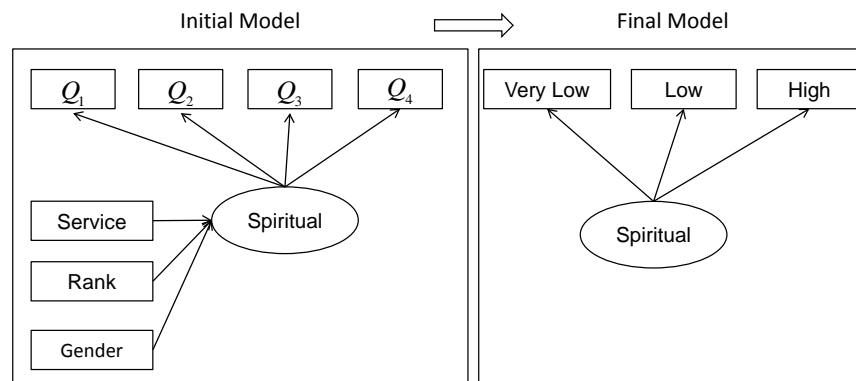
Figure 47. Updated TRAC body slide.

Final Resiliency Rating

Resilience Rating

GAT Subscale		Very High	High	Moderate	Low	Very Low
	FA	Satisfied	Satisfied	Satisfied	Satisfied	Neutral
	SO	Satisfied	Satisfied	Satisfied	Satisfied	Dissatisfied
	SP	High	High	High	High	Low
	CA	Calm	Calm	Calm	Calm	Upset
	DEP	Not Depressed	Not Depressed	Low Energy	Low Energy	Mildly Depressed
	NA	Upbeat	Upbeat	Mildly Stressed	Mildly Stressed	Overwhelmed
	PA	Optimistic	Optimistic	Happy	Happy	Balanced
	AD	Introvert	Acquiescent	Acquiescent	Acquiescent	Impulsive
	CHA	Extraordinary	Extraordinary	Average	Average	Low
	ACT	Very Active	Very Active	Very Active	Somewhat Active	Somewhat Active
	HEA	Excellent Sleep/Balanced Diet	Poor Sleep/Poor Diet	Excellent Sleep/Balanced Diet	Poor Sleep/Poor Diet	Poor Sleep/Poor Diet
	NUT	Semi-Vegetarian	Grain-Based	Semi-Vegetarian	Grain-Based	Carnivore

FA – Family SO – Social SP – Spiritual CA – Catastrophizing DEP – Depression NA – Negative Affect PA – Positive Affect AD – Adjusting CHA – Character ACT – Activity HEA – Health NUT – Nutrition

17 August 2015   GAT 2.0 Exploratory Analysis IPR   13

Figure 48. Current TRAC slide with a table.
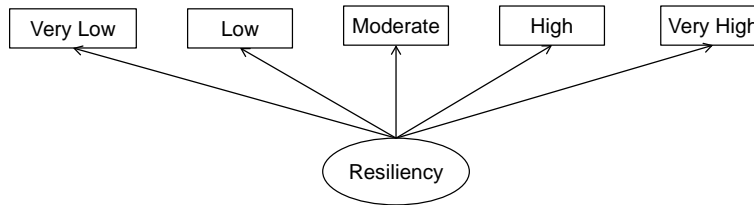
Figure 49. Updated TRAC body slide.

The profiles for very high and high had differences in adjusting, health, and nutrition.

GAT Category	Resilience Rating				
	Very High	**High**	Moderate	Low	Very Low
Family	Satisfied	Satisfied	Satisfied	Satisfied	Neutral
Social	Satisfied	Satisfied	Satisfied	Satisfied	Dissatisfied
Spiritual	High	High	High	High	Low
Catastrophising	Calm	Calm	Calm	Calm	Upset
Depression	Not Depressed	Not Depressed	Low Energy	Low Energy	Mildly Depressed
Negative Affect	Upbeat	Upbeat	Mildly Stressed	Mildly Stressed	Overwhelmed
Positive Affect	Optimistic	Optimistic	Happy	Happy	Balanced
Adjusting	Introvert	Acquiescent	Acquiescent	Acquiescent	Impulsive
Character	Extraordinary	Extraordinary	Average	Average	Low
Activity	Very Active	Very Active	Very Active	Somewhat Active	Somewhat Active
Health	Excellent Sleep/ Balanced Diet	Poor Sleep/Poor Diet	Excellent Sleep/Balanced Diet	Poor Sleep/Poor Diet	Poor Sleep/Poor Diet
Nutrition	Semi-Vegetarian	Grain-Based	Semi-Vegetarian	Grain-Based	Carnivore

Figure 50. Updated TRAC slide with a table (1 of 3).

The profiles for moderate and low had differences in activity, health, and nutrition.

GAT Category	Resilience Rating				
	Very High	High	Moderate	Low	Very Low
Family	Satisfied	Satisfied	Satisfied	Satisfied	Neutral
Social	Satisfied	Satisfied	Satisfied	Satisfied	Dissatisfied
Spiritual	High	High	High	High	Low
Catastrophising	Calm	Calm	Calm	Calm	Upset
Depression	Not Depressed	Not Depressed	Low Energy	Low Energy	Mildly Depressed
Negative Affect	Upbeat	Upbeat	Mildly Stressed	Mildly Stressed	Overwhelmed
Positive Affect	Optimistic	Optimistic	Happy	Happy	Balanced
Adjusting	Introvert	Acquiescent	Acquiescent	Acquiescent	Impulsive
Character	Extraordinary	Extraordinary	Average	Average	Low
Activity	Very Active	Very Active	Very Active	Somewhat Active	Somewhat Active
Health	Excellent Sleep/ Balanced Diet	Poor Sleep/Poor Diet	Excellent Sleep/Balanced Diet	Poor Sleep/Poor Diet	Poor Sleep/Poor Diet
Nutrition	Semi-Vegetarian	Grain-Based	Semi-Vegetarian	Grain-Based	Carnivore

Figure 51. Updated TRAC slide with a table (2 of 3).

The profile for very low had different ratings for each GAT category.

GAT Category	Resilience Rating				
	Very High	High	Moderate	Low	Very Low
Family	Satisfied	Satisfied	Satisfied	Satisfied	Neutral
Social	Satisfied	Satisfied	Satisfied	Satisfied	Dissatisfied
Spiritual	High	High	High	High	Low
Catastrophising	Calm	Calm	Calm	Calm	Upset
Depression	Not Depressed	Not Depressed	Low Energy	Low Energy	Mildly Depressed
Negative Affect	Upbeat	Upbeat	Mildly Stressed	Mildly Stressed	Overwhelmed
Positive Affect	Optimistic	Optimistic	Happy	Happy	Balanced
Adjusting	Introvert	Acquiescent	Acquiescent	Acquiescent	Impulsive
Character	Extraordinary	Extraordinary	Average	Average	Low
Activity	Very Active	Very Active	Very Active	Somewhat Active	Somewhat Active
Health	Excellent Sleep/ Balanced Diet	Poor Sleep/Poor Diet	Excellent Sleep/Balanced Diet	Poor Sleep/Poor Diet	Poor Sleep/Poor Diet
Nutrition	Semi-Vegetarian	Grain-Based	Semi-Vegetarian	Grain-Based	Carnivore

Figure 52. Updated TRAC slide with a table (3 of 3).

Chapter 4
Conclusion and Further Work

Conclusions

Conclusion 1: The latest research on design, cognitive learning, and visualization formed the basis of our methodology.

First, design thinking provides the base for our methodology. Specifically, the five-step process of design thinking helps to guide and focus the analyst on keeping the viewing audience at the center of visualization development. Furthermore, design thinking is the appropriate model to use since a visualization is a product of a design and not a deliberate process like the MDMP. Second, the CTML provides the basis for understanding how the audience processes visualizations. In essence, learning the techniques that take advantage of the parallel processing power of the human visual system, along with reducing cognitive load makes an analysts use of visualizations more useful. Third, the Gestalt principles provide the ground rules for building visualizations. In other words, these principles guide an analyst in the process to ensure their visual design is as simplistic and sophisticated as possible. Finally, the results of a color analysis filled in TRAC's gap in capability. By separating the functions of the color palette's TRAC analysts have clearer guidance on the use of color when presenting their analysis findings.

Conclusion 2: Our methodology provides a solid foundation to develop, analyze, and present visualizations.

The "Beyond Bullet Points" outline helps to create a good analysis story. The outline contains all the necessary elements for a good story such as a beginning, middle, and ending. Most importantly, the outline also forces the analyst to create a specific action they want the audience to do with the presented information. Hence, the final presentation will have a tight focus and flow for the audience to follow. Also, the Munzner nested analysis method ensures the analyst uses the most efficient supporting visualization. This methodology provides not only a comparison between two types of visualizations, but it also provides a process to analyze the context of the use of the visualization. Moreover, the "Assertion-Evidence" presentation template provides a compelling method to tell the story. By capitalizing on the good aspects of a presentation document, this method provides a clear distinction in the function of the presentation versus a stand-alone report. As a result, the analyst can better decide on which format is best to use for a particular venue.

Conclusion 3: Our methodology extends the goodness of the current TRAC documentation standard.

A design-based approach fosters communication that focuses on supporting the decision maker. Likewise, rapidly prototyping visualizations foster more innovation and creativity. Equally important, a repeatable analysis methodology lends the credibility to the visualization choices.

Further Work

Our future work will focus on training, updates to the TRAC standards, and researching and developing techniques for dynamic analysis. First, we must socialize and implement training that teaches analysts how to incorporate these design principles into their analytics products. Consequently, TRAC analysts will better communicate their analysis findings, and TRAC customers will receive a higher quality product. Second, we must integrate these principles into the current TRAC standards. This update to the TRAC standards will ensure that TRAC maintains its current brand while simultaneously modernizing its methodologies and products. Finally, we must develop methods that drive TRAC's analysis products towards the web. There is a growing need among senior leaders and stakeholders to have a dynamic capability when receiving the results of a TRAC analysis or study. Utilizing web-based tools help to keep the findings and results of a TRAC analysis relevant and timely for many consumers of this critical information.

Appendix A
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Appendix B
TRAC Presentation Outline

This appendix contains a modification of the "Beyond Bullet Points" outline developed by Atkinson for use when developing a TRAC presentation.[1] In short, each cell of the presenter will use the information in each cell to build the title for the slides used in their presentation. We give a short description of how to utilize each section of the outline, and refer the reader to Atkinson for further detail.[2]

Act I: Establish what you are going to discuss

In this section of the outline, the presenter establishes the purpose of the presentation and provides the relevant context for why the presented information is valuable to the audience. The first portion of this section discusses the following:

- purpose—What are you discussing with the audience?
- setting—What is the overall context for the problem?
- role—Why is the audience here?

Next, the presenter develops headlines for the current problem, call to action, and the end state. The current problem headline establishes the analytic challenge the audience faces, and the end state determines what the audience should know after receiving the information in the presentation. The call to action is the connection between the current problem and the end state that helps the audience to visualize how they will arrive at the end state. In other words, the call to action should indicate what the presenter wants the audience to do with the information they receive.

Finally, the presenter can insert additional details relevant to the audience such as constraints, limitations, and assumptions; methodology, or other pertinent details. The key takeaway to this extra information is that each new cell creates an additional slide in the presentation, and the presenter must keep in mind the time constraints for the presentation.

Act II: What are the supporting details for the call to action?

Act II of the outline is rather a straight forward process. To start, the presenter will create a headline for the major conclusions of the briefing. The presenter should note that the

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[1] Cliff Atkinson. *Beyond bullet points: Using Microsoft PowerPoint to create presentations that inform, motivate, and inspire.* Pearson Education, 2011.

[2] Ibid.

default number of cells is three. This number is not arbitrary, but based on research that most people can effectively process between three to four chunks of information.[3] Thus, the presenter must scrutinize their exploratory analysis details and discuss only the most pertinent details. Next, the presenter will support each conclusion with three to four points of analysis. In a like manner, the presenter will augment each point of analysis with three to four supporting facts. An advantage to this structure is that the presenter can prune their presentation according to the audience or time available for the briefing. A disadvantage is that this process is time consuming, but the presenter can work with a team or develop the outline iteratively while developing their final report.

Act III: Conclusion

This final section of the outline is just a placeholder and points out to the presenter that they should only use one or two slides to review the key points of the presentation.

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Title and Byline		
Act I: Establish what are you are going to discuss.		
Purpose (what are you discussing with the audience)		
Setting (What is the overall context for the problem?)		
Role (Why is the audience here?)		

Current Problem	Call to Action	End State
Constraints	**Limitations**	**Assumptions**

Act II: What are the supporting details for the call to action?		
Conclusions (5 minutes)	**Analysis** (15 minutes)	**Supporting Facts** (45 minutes)

Act III: Conclusion

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Appendix C
Glossary

CTML   Cognitive Theory of Multimedia Learning
DoD   Department of Defense
IPR   In Progress Review
MDMP   Military Decision Making Process
SOD   Systemic Operational Design
TADP   TRAC Analyst Development Program
TRAC   Training and Doctrine Command Analysis Center
TRADOC   Training and Doctrine Command
UML   Unified Modeling Language